THE

TWENTY-FIRST

ANNUAL REPORT

OF THE

MARYLAND

Agricultural Experiment Station,

COLLEGE PARK

PRINCE GEORGE'S CO., MARYLAND.

1907—1908.

PUBLISHED BY THE STATION.

—THE—

Maryland Agricultural Experiment Station.

CORPORATION.

The Board of Trustees of the Maryland Agricultural College.

*On State Horticultural Department Work.

The Station is located on the B. & O. R. R. and City & Suburban Electric Car Line, eight miles north of Washington, D. C.
Bell Telephone—Hyattsville 4 R.

Visitors will be welcome at all times, and will be given every opportunity to inspect the work of the Station in all of its departments.

The Bulletins and Reports of the Station will be mailed regularly, free of charge to all residents of the State who request it.

ADDRESS:

AGRICULTURAL EXPERIMENT STATION.

College Park, Maryland.

LETTER OF TRANSMITTAL.

To His Excellency, Austin L. Crothers,

Governor, and President of the Board of Trustees,

Annapolis, Md.

Sir:—In accordance with the provisions of Section No. 3, of the Act of Congress, approved March 2, 1887, "To Establish Agricultural Experiment Stations," etc., I have the honor to transmit the Twenty-first Annual Report of the Maryland Experiment Station for the fiscal year ending June 30, 1908.

Very respectfully yours,

H. J. PATTERSON,

July, 1908. Director of the Experiment Station.

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THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

Volume 21. 1907-1908.

Report of the Work and Expenditures of the Maryland Agricultural Experiment Station.

FOR THE YEAR ENDING JUNE, 1908.

BY H. J. PATTERSON, Director.

To the Honorable Board of Trustees of the

Maryland Agricultural Experiment Station.

Gentlemen: I have the honor to submit for your consideration a report upon the work of this institution for the fiscal year just ending, and an outline setting forth the most important facts relating to the existing status and policy of the Station and the new lines of work which have been taken up since the last annual report.

THE FUNCTIONS OF THE STATION.

The past year has marked a decided broadening of the scope of the investigations and an increase in the equipment and facilities for conducting the same. The condition of the Station and its equipment is in the main gratifying and satisfactory to the Station workers; yet it is to be said that this institution is relatively in its infancy and still in the process of development and therefore real needs exist which must be supplied from time to time if there is to be progress in equipment and organization so as to make this institution an efficient factor in ministering to agricultural ills and a leader and moulder of advanced agricultural thought.

The question as to the range of the work that the Station should undertake to do is an ever-recurring one. Theoretically its primary office is to establish facts and principles that shall serve as a safe guide for conducting and developing agricultural practice. The effort cannot stop with this however. It is equally the duty of such an institution to suggest new applications of knowledge, verify conclusions in relation to agricultural practice and disseminate the results of its investigations.

All this is being done in some measure and the continued approval of the Station efforts by the agricultural public is a reasonable assurance that the work is regarded as helpful. Nevertheless it is sometimes doubtful whether the real functions of the Station are not being encroached upon, and too much time being devoted to what is truly demonstration work and teaching of a popular character. This latter class of work is highly valuable and essential, but ought to be provided for more liberally by State funds and done in such a way as to not interrupt the work of the investigators.

It is very certain that the members of the Staff cannot properly and successfully carry on important investigations and experiments unless they can give to such work their uninterrupted attention through a large portion of the year, a fact that is not fully appreciated by those without experience in studying scientific problems.

Popular teaching is important and highly essential, but belongs properly to the functions of the College, its farmers' institutes and agricultural extension. The discovery of facts and principles by careful and severe inquiry so as to establish knowledge and place it on a basis for popular teaching constitutes the paramount work of the Experiment Station.

It needs but a glance at the progress of agriculture in the United States during the past twenty years to show the powerful influence of a few important discoveries. The Station workers who have established truths of general importance stand in the front rank of agricultural benefactors. As long as there are so many important problems unsolved and the Station is the recognized agency in each State for research, it would seem desirable for it to confine its best efforts to its special field.

PUBLICATIONS.

The investigations which have been completed or advanced sufficiently to warrant a report of progress have been printed in bulletin form and are covered in the following list which has been issued during the past year:

No. 119, July, 1907—Greenhouse Pests, by A. B. Gahan, pp. 1 to 36.

No. 120, August, 1907—Sweet Corn Investigations, by M. N. Straughn, pp. 38 to 78.

No. 121, September 1907—Beef Cattle Industry of Maryland, by B. E. Porter, and the Cost of Growing Beef Cattle, by H. J. Patterson, pp. 79 to 116.

No. 122, October, 1907—Stable Manure Experiments, by W. T. L. Taliaferro and H. J. Patterson, pp. 117 to 138.

No. 123, November, 1907—San Jose Scale, by T. B. Symons and G. P. Weldon. The Peach Lecanium, by A. B. Gahan, pp. 139 to 160.

No. 124, December, 1907—Strawberries, by C. P. Close, W. R. Ballard and T. H. White, pp. 161 to 195.

HORTICULTURAL OFFICES, LABORATORIES AND GREENHOUSES.

No. 125, February, 1908—Nut Growing in Maryland, by C. P. Close, pp. 196 to 217.

No. 126, April, 1908—Manuring and Fertilizing Truck Crops, by C. P. Close and T. H. White.

No. 127, May, 1908—Experiments with Miscellaneous Vegetables and Fruits, by C. P. Close, W. R. Ballard and T. H. White.

No. 128, June, 1908—Effects of Digestion and Fermentation of Manure on the Vitality of Seeds, by E. I. Oswald.

STATION STAFF.

There has been two changes in the Station Staff during the year both of which were caused by resignations which took effect January 1. The position of Assistant Chemist caused by the resignation of Mr. J. J. T. Graham has been filled by the appointment of L. B. Broughton, a graduate of this College in the chemistry course in this year's class.

BUILDING.

The equipment of the Station has been enlarged during the past year by the addition of a new dairy barn, a new building for the horticultural offices and laboratories, three new greenhouses, an incubator house and laboratory for poultry investigations and poultry houses. Pictures of these buildings are included in this report.

INVESTIGATIONS.

The outline given in the following paragraphs is not intended to give a complete list of the investigations now under way or to indicate the activities of the several departments; but is intended only to supplement former reports and bring to your attention such new matters as are receiving consideration and which it may be desirable to take up in the near future.

AGRONOMY DEPARTMENT.

The work now being conducted by this department is the same as outlined in the 20th annual report. It is hoped that facilities may soon be available so as to broaden the scope of the work of this division considerably, and make it cover more completely a wider range of territory and also take up work with all the cereals and more forage crops. The work of this department has been interrupted considerably by the resignation on January 1 of Mr. V. M. Shoesmith.

The work outlined for this season is as follows:

Corn.

1. Breeding of Leaming & Munnikhuysen corn.
2. Testing of the degree of inbreeding or close breeding, which may be safely practiced.
3. Testing Leaming seed from different sources.
4. Variety tests at the Experiment Station including 17 varieties.
5. Cooperative variety tests with 40 farmers in different parts of the State. Five of these tests include six or more varieties and the rest include the Leaming corn and one or two local varieties.

Wheat.

1. Breeding plots of Currell and Fultz.
2. Variety and selection tests including 26 plots of 1-20 acre, 22 of 1-40 acre and 47 of 1-80 acre, besides 134 smaller plots used mainly for increasing the amount of seed.

Cowpeas.

1. Breeding plots of three varieties.
2. A variety test.
3. A study of the methods of harvesting and threshing cowpea seed.

Alfalfa.

1. Breeding.
2. Testing seed from different sources.
3. Fertilizer tests.
4. Methods of preparation of seed-beds.
5. Cutting experiments.
6. Culture experiments.

Clovers—Red, Mammoth, Alsike and White.

1. Breeding.
2. Tests of seed from different sources.

Greenhouse Work.

1. Growing of plants of several varieties of cowpeas to be used as material for breeding and study.
2. Growing of selections of alfalfa and clover made from field breeding plots in 1907.
3. Fertilizers on alfalfa.
4. Fertilizers on red clover.

New Work.

The work outlined above is mainly a continuation, on a larger scale in some cases, of the work in progress during the season of 1907. Other experiments relating to the same lines will be undertaken later in the season, if circumstances will permit.

A line of new work deserving more attention by this department as soon as the funds are available, is the variety testing and breeding of corn, wheat and other crops in those parts of the State where the climatic and soil conditions are much dissimilar to those at the Station farm. These parts are Maryland west of the Alleghanies, the Piedmont region and the Eastern Shore of Maryland. Some good cooperators among the farmers are found on the Eastern Shore and work there for a time at least should be confined to cooperative work, but in the other two sections of the State the farmers are less alive to the work of the Station and in each of these sections arrangements should be made to secure by lease or otherwise, the use of four or more acres of land adapted for experimental purposes. The work for the first year should include a variety test of eight or ten of their local varieties of corn and wheat, and as many more standard varieties from outside sources. Other crops special to that part of the State, such as buckkwheat and oats in Western Maryland might also be included in the test. As soon as possible all but two or three of the best varieties of each crop should be eliminated and these improved by breeding and selection. As soon as a desirable breed is obtained of any crop, seed from it should be planted in increase plots so as to get seed for dissemination among the farmers. This work would bring the Agronomy department in close touch with the farmers in those sections and give better opportunities for extending cooperative work.

Another piece of outlying work that might be undertaken is a variety test of corn at one or two points where the farmers do not believe that the type of corn recommended by the Station makes as good yields as the type they are growing. The test might include ten varieties popular with the farmers and ten varieties chosen by the Station. The purpose of this experiment would be to show the comparative yield of the varieties at husking time, by weight and by measure. To show the comparative yields of the corn when weights are taken in February or March, both of corn on the ear and corn shelled, and to show the percentage of shelled corn of each. Fifty-pound samples should be saved of each variety at husking time for making the latter determinations.

A study of the dominance of color characters and the flint, dent and sweet characters of corn to test the principles brought out by Mr. East of the Connecticut Experiment Station in his report for the year 1907, should if possible be started this fall. This test requires four seasons. All the crosses are made the first year. The remaining seasons the ears are planted in separate rows and the corn self-pollinated by hand.

An attempt will be made in the greenhouse to breed up a more acid resistant alfalfa. This will be done by filling one of the solid beds of the greenhouse with acid soil and trying plants of different varieties there. Seed of the most resistant plants will be saved for the second planting. The unlimed strip south of Agronomy building will furnish suitable soil for this purpose.

BOTANICAL DEPARTMENT.

The work of this department for the past year has been mainly a continuation of that outlined in last year's report. There has been a very large number of samples of seeds, especially clover and alfalfa, submitted for the determination of their purity and vitality. The clover has shown an unusual amount of Dodder and other European weeds.

An investigation has been begun with the value of self-boiled lime and sulphur spray for plant diseases.

This department desires to pursue during the coming year a study of The Effect on Plant Structure and Physiology of the Internal Application of Different Substances, with the end in view of determining:

1. How plants are killed or injured by the application of chemicals.
2. May any substance so introduced affect the resistance or susceptibility to disease.
3. Can nutrition be so supplied.
4. The path and movement of substances in plant tissues.

Economic Problems Upon Which the Work May Bear.

1. The eradication of weeds.
2. The injury of plants by sprays.
3. The injuring of plants by strong fertilizers.
4. Killing worthless trees and shrubs.
5. The control of plant diseases.
6. The variation in vigor or vitality of different individuals or varieties.
7. The transfer of vital characteristics from one plant to another by transfer of juices.
8. Application of nutrition to plants with poor or diseased root system.
9. Additional water supply to such.
10. Additional nutrition to plants grown under intensive cultivation for quick production or large growth.

CHEMICAL DIVISION.

The greater part of the time of this division during the past year has been consumed in the studies of the pathological and physiological

nature of milk. This work consumed almost the entire time of one man. The sweet corn investigations together with the miscellaneous samples and routine work of investigations outlined in previous reports took up the time of the second assistant chemist.

DAIRY INVESTIGATIONS.

The dairy investigations now under way can be divided into two classes: 1st. Those which relate to the production of milk and a study of all the factors which influence its value as food. 2nd. A study of the conditions surrounding the making of butter in Maryland with a view of determining the reasons for lack of uniformity in quality, so that ultimately directions may be given which will enable the creameries of Maryland to make as good and uniform a quality of butter as is now supplied by the Northern and Western districts that command the best prices in our markets.

ENTOMOLOGICAL DEPARTMENT.

The investigations being pursued by this department may be summarized under the following heads:

I. Fumigation of buds in the nursery with hydrocyanic acid gas.
(Tests to determine the maximum strength of gas that the buds will stand without injury and the least amount that will be effective in killing the San Jose Scale.)
(This has continued for two years.)

II. Dipping nursery trees in different insecticides.
(To ascertain the effect of such treatment on the stock after being planted in the field and also the effectiveness of treatment in controlling San Jose Scale.)
(Continued for two years.)

III. Testing different insecticides for the control of San Jose Scale on orchard trees.

(The numerous inquiries in regard to the effectiveness of the many new solutions that appear on the market makes it advisable to determine actual facts in regards to their ability to control the pest.)

IV. Treatment with arsenate of lead (different brands) and paris green to control the Codling Moth. Study of life history continued.

V. Treatment with arsenites for the control of the Plum Curculio.
(This investigation was commenced in 1906, but climatic conditions has prevented much work being done.)

DAIRY BARNS.

VI. Treatment with arsenites for the control of the asparagus beetles.

(There is no practical means of combating these beetles and it is hoped that a persistent syraying with arsenites on old beds will be found advantageous.)

VII. Tests with different materials in an effort to secure a good and practical repellant for the flea beetles, rose bugs, etc.

(It is possible that a repellant may be found to prevent injury from the flea beetles. These pests cause much injury to many of our truck crops.)

VIII. Miscellaneous.

(Continuation of the studies of the life history of the Oyster Shell and Scurvy Scale insects. Continuation of the work on the mosquitoes of the State with experiments with different larvacides. Tests of methods for combating the Peach Tree Borer.)

IX. Study of the parasitic Hymnoptera with special reference to the family Braconidae.

HORTICULTURAL DEPARTMENT.

The investigations being conducted in this department are a continuation of those outlined in last year's report, with the addition of many new projects. The enlargement of the greenhouse facilities will make it possible to take up some new investigations with the growing of flowers and vegetables under glass. The results of all of the investigations completed up to this time have been issued in bulletin form during the past year:

The following lines of work are now being pursued:

Truck crops in young apple orchard—E. P. Cohill—seven one-half acre plots, one plot each of sweet corn, sweet potatoes, Irish potatoes, muskmelons, tomatoes, strawberries and one check.

Variety peach orchard—E. P. Cohill, Hancock, Md.—About 100 varieties for testing.

Variety peach orchard—W. F. Allen, Salisbury—About 100 varieties for testing.

Apple breeding—About 700 blossom clusters were crossbred, using summer varieties together and two winter varieties together. Of the seed secured in 1907 there are now 510 seedlings growing. These were started in the greenhouse.

Pear breeding—About 500 blossom clusters were crossbred this year. This is an attempt to combine the hardiness, vigor and productiveness of the Kieffer with the good qualities of the Seckel, Anjou, Duchess, etc.

Spraying with different strengths of Bordeaux to determine weakest strength which will hold the apples to the trees. In connection with this test two poisons of two different strengths are used against the codling moth by the Entomologist.

Cover crops in Station orchard.

Mulching strawberries.

Mushroom growing—Test of varieties, fertilizers and mulching. This was a failure because the uncovered steam pipes running through the room kept the temperature too high.

Dwarf pear and apple orchard—to be budded to the seedling apples and pears in the breeding work.

Pap paw—Growing seedlings and improved varieties.

New raspberry plantation—To test distances of planting and pruning and training.

Effects of fertilizers on the structure of plants.

Variation of plants by excess of food fertilizers in various forms.

Commercial fertilizer and cover crops in apple orchard—W. G. Dawson.

Commercial fertilizer and cover crops in apple orchard—E. P. Cohill.

Commercial fertilizer and cover crops in apple orchard—W. F. Allen.

Variety test of geraniums to test resistance to disease, hardiness and vigor of plant.

Experiments in preserving strawberries and other fruit especially with a view of retaining the color.

Pollination studies with apples and pears.

Recording the leafing and blooming periods of apples, peaches, plums, pears, blackberries, raspberries, strawberries, currants and gooseberries.

Picking, weighing and recording yields of orchard and small fruits.

Application of copper sulphate solution to soils planted to tomatoes to test its effect in rendering plants immune to disease.

Testing varieties of tomatoes, sugar corn, cabbage and Irish potatoes.

Testing rust-proof Rocky Ford cantaloupes.

Planting sweet potatoes continuously on same soil.

Testing potato seedlings.

Fertilizer experiments on asparagus.

Varieties of violets with investigation into their requirements as to soils and fertilizers.

Continuation of experiments with carnation cuttings in relation to the vigor of the plants.

Commercial fertilizer on truck crops.

Improvements of varieties of strawberries by seed selection.

New Work.

Distribution of 912 Persian walnut and pecan trees—433 of these are in 13 test nut orchards of 20 to 50 trees, in 12 counties. Seventy-five nut trees were planted on the Station and College grounds which with the few trees distributed in College Park make 1000 nut trees planted through the efforts of the department.

Grafting Persian walnuts—285 were root grafted on one-year seedling black walnuts and Persian walnuts. A few limbs of black walnut were grafted to the Persian.

Grafting black walnuts on black walnut seedlings.

Budding Persian walnuts on black walnut limbs.

Planting nuts—3 bushels of black walnuts; No. 20 San Jose Persian; No. 30 Franquette; No. 6 Cumberland; No. 2 Peerless and No. 10 Maryland grown nuts.

Pruning pecans—Ordinary long root pruning vs. stub pruning.

Saving seed of varieties of cabbage resistant to disease and extremely unfavorable conditions.

Saving seed of Golden Self-Bleaching Celery and testing against California-grown seed.

Potatoes—Investigations into causes affecting yields of Irish potatoes:

1. Home grown seed of several varieties against Maine grown and second crop Virginia seed.
2. Eyes cut from "stem" end, and also from "seed" end and planted separately.
3. Tubers selected from several varieties that show very weak sprouts when allowed to sprout before planting as against selected tubes with strong sprouts.
4. Various sizes of tubers cut and uncut.
5. Tubers from which all sprouts have been removed just before planting as against those with sprouts left on.

Geranium breeding.

(a) Production of bedding varieties adapted to Maryland conditions.

(b) Application of Mendel's law.

(c) A study of color relations.

(d) Hybridization.

Selection work with pansies.

An experiment to test the rooting of cuttings, of a number of varieties of apples.

Effect of fertilizers on the growth of cabbage when applied to the land in the spring as against an application just before planting at midsummer.

Effect upon the growth and maturity of cabbage when the plant beds are supplemented with excessive amounts of the different plant foods.

New Work in Greenhouse.

Methods of Ventilation as related to the prevalence of mildew on roses.

Effect upon the growth of roses, carnations, chrysanthemums and violets, when the manure used is obtained from cattle that are bedded with sawdust, litter or no bedding.

Improvement of carnations by selection of seedlings produced by self-pollination.

An investigation into the causes of doubling of various plants especially as to pruning and manuring.

Effects of excessive amounts of Gypsum, lime (caustic), sulphur, iron filings, copper sulfate, phosphoric acid soluble and insoluble, dried blood, muriate and sulfate of potash upon the variation of tomatoes.

Variety testing of chrysanthemums, tomatoes and English musk-melons.

POULTRY INVESTIGATIONS.

The investigations with poultry as previously outlined may be divided into two classes, viz: Commercial problems and studies on incubation and poultry diseases. The former tests are being conducted by Mr. C. L. Opperman and the latter by Dr. Robert Mayo. Dr. Mayo worked on these problems for three months last summer, and will resume the studies again on June 1, under the plan which has already been approved by this board. The following is an outline of the commercial problems now in progress:

The first five months of the year was devoted to raising stock and getting the buildings into shape for experimental work. There was practically no real research work done except the keeping of the records of the fowls on hand, and some metereology tests in the incubator cellar. These records have been carefully filed away and will be compiled some time during the year, and if anything of value is found it will be used in a bulletin.

During the latter part of October preparations were begun for starting a general test of poultry houses, to ascertain if possible what type of house is best adapted to Maryland's climate. There were about 300 pullets reared for this experiment. They were carefully weighed, leg banded, and selected so that each type of house would have practically the same number of pounds of live weight and the same number of fully developed birds of the same age. Considerable care was exercised to have these conditions as near exact as possible.

This experiment was started November 5, 1907, and has been progressing very favorably to the present date.

All fowls are trap-nested, and the records of each individual hen is carefully kept. All the feed that is used by each type of house is carefully weighed, and a record kept of the same. During the months of November, December, January and February the temperature and

humidity of the houses were carefully recorded each day. In the houses that are equipped with the hooded roosts, the difference in temperature between the roost and the outside pen was carefully recorded.

In connection with this experiment considerable incubation and brooding work is being done to determine what effect the type of house has on the fertility of the eggs, the strength and vitality of the young chicks. To carry out this work the Department secured six Model Incubators, and twelve indoor Prairie State Brooders, which have given good satisfaction. There has been incubated from each pen 300 eggs, making a total of 1800, from which has been secured 924 chicks. Careful records of the incubation and brooding are being kept. From the last hatch which was made in April, twenty pullets from each type of house will be reared. During the latter part of October the twenty poorest hens in each type of house will be taken out; these will be replaced by the pullets reared during the summer. This will give data on the effect on the next generation while work is continuing with the first generation. This experiment will be carried on practically the same next year, with the addition of any points that will make it more efficient.

The Effect of Wet and Dry Mash on Egg Production with Two-Year-Old Hens.

This experiment was started on December 4, 1907, and continued until April 8, 1908. The experiment consisted of two pens of fifteen fowls each. One pen received grain morning and evening, with a warm mash at noon. The other pen received grain morning and noon, with dry mash before them at all times. Records were kept of all the food consumed, and the eggs produced by each pen. The general health of the fowls was observed from time to time.

The Breeding of Barred Plymouth Rocks for Egg Production.

During the early part of the summer the Department, through the kindness of Mr. McGrew, of Washington, secured 60 eggs from birds that had attracted attention by their remarkable egg production. From these eggs only 10 pullets were secured. Records of the work of these hens are being kept and the eggs used for increasing the stock for further experiments.

VETERINARY DEPARTMENT.

The work of this department for the past year has been of a diversified nature, owing to the construction of new barns and the necessary abandonment of the old structure in the early part of the year. The milk investigations begun two years ago, and from which the microscopical studies indicated important chemical changes under certain conditions, have been fully borne out by subsequent chemical examinations. It is important now that these examinations (micro-

POULTRY HOUSES AND LABORATORIES.

scopical and chemical) be carried along together, in order to perceive their fullest significence.

The bacteriological studies are not to be disregarded, but just now the important work is microscopical and chemical until a knowledge of all milk constituents is had; later bacteriological and other conditions can be taken up to determine their influence upon such constituents.

The histological study of the cow's udder was begun for the reason that no satisfactory information was available upon this very important organ, and milk studies without such knowledge would be superficial. There has recently been published from Europe, what appears to be a very carefully prepared contribution to this subject, which doubtless, will serve most purposes for milk studies. The especial study of blood and lymph vessels is, however, necessary.

In addition to the milk work there have been made a number of tuberculin tests and vaccinations. The value of tuberculin is shown to be dependent upon proper administration, and carelessness in this respect has tended to discount its real value in many instances. A full discussion of this subject will be given in a report which is in preparation.

The introduction of bills on three subjects at the last session of the General Assembly, all of which failed to pass, makes it important to enter at once upon a study of the needs of such legislation and the extent to which it should be carried as well as the probable effects. Two of these bills originated with the State Board of Health, the third from a dairy interest. The subjects, rather than the bills, should be considered, and are (a) Meat Inspection, (b) Milk Inspection, (c) Tuberculosis.

The report of this department in 1896 suggested an inquiry into (1) Cooperative Slaughter-houses in various parts of the State, whereby the producer could realize the greatest returns from his animals; (2) the investigation of Cerebrospinal Meningitis in horses; (3) Cooperation with the State in investigating sanitary conditions, and aid in perfecting them.

These recommendations are just as appropriate after a lapse of twelve years. The Board of Health bill on slaughter-houses was drafted primarily to safeguard the health of the State by regulating the practice of slaughtering, transporting, keeping and selling meats for human food. The producers of food-producing animals would receive greater returns for their animals if slaughtered at central points where offal could be utilized. Inspection could be practiced with profit, and no one injured by the adoption of such central slaughtering points. However, it proved unwise to seek legislation before existing conditions and practices were known as the fate of the bill shows.

Cerebrospinal Meningitis investigations have been made when ever the disease appeared, with profit, and the work of this Station in connection with Johns Hopkins Medical School has placed the

pathological knowledge of this disease on a higher plane than it ever before held in this country.

The cooperation in sanitary matters has not been extensive, but should be. In justice to the farmer, our Station should closely study the laws and regulations which are constantly thrown around his work and the products of his work, in order to protect him against unwisely imposed regulations that have no real value and to aid him in securing proper returns for expenditures incurred in wise regulations made necessary for the public good. This subject is important and should be carefully studied. Upon it depends Tuberculosis control, Milk and Meat Inspection, and Pure Food control. In this particular, also legislation was asked without actual knowledge of existing conditions.

The time of one person could very profitably be spent in touring the State to collect information upon the cost of production of meat and milk, upon the conditions surrounding the production of these, the location, number, size and general information of the topics above referred to.

Studies of combinations of food materials, with and without condiments is important, and a search for some cheaper substances not regarded at present as food stuffs should be made. While practically all by-products of food are utilized, yet high prices for foods and moderate prices for animal and dairy products still prevail.

COOPERATIVE EXPERIMENTS.

The Station continues to cooperate with the United States Department of Agriculture in all the lines of work given in the last annual report, and in addition to those has taken up some work with the Forestry Bureau on the treatment of fence posts so as to preserve them and lengthen their life and at the same time make it possible through this treatment with preservatives to use many of the abundant and cheap woods that are not used at present. There are 19 different native woods being used in this test.

COOPERATIVE TOBACCO EXPERIMENTS

WITH THE

UNITED STATES DEPARTMENT OF AGRICULTURE.

Tobacco growing has been the important farm industry of the larger part of Southern Maryland since the settlement of the Colony. For many years, however, the industry has not been sufficiently profitable to bring about a reasonable degree of prosperity. A number of causes have brought about this condition.

Men qualified to pass judgment very readily concede that any of the standard crops of Southern Maryland could profitably be made to produce double the yield, on the average, which they now do.

The methods of the past have been such as to diminish and finally exhaust the crop-producing power of the soil. Those of the future must build up and increase its crop-producing power. The tobacco growers' problem cannot be handled adequately without dealing to a considerable extent with the other crops to be grown in rotation with tobacco. This is the key to the situation. The success of the tobacco crop itself depends quite as much upon the crops grown and treatment given the fields in the interim between the successive crops of tobacco as upon the attention given the tobacco itself. By the development and introduction of the very best methods of fertilization, cultivation and handling of the crops grown or desirable to be grown in rotation with tobacco, it is believed that the soil can not only be put in much better condition for producing profitable crops of tobacco, but they can also be made of such greatly increased importance and value as to add very materially to the income of the farm, and in a sense, therefore render the farmer less dependent upon tobacco.

The soils humus content must be built up by growing more leguminous and forage crops and growing them in systematic rotation with the more exhaustive crops like corn, wheat and tobacco.

Much is yet to be learned concerning the best use of commercial fertilizers. When adequately supplemented by humus crops there is but little question that they can be used to much greater advantage than at present, particularly in connection with the production of the tobacco crop itself.

Good seed is another important detail for successful farming. It is now becoming generally recognized that there is as much in improved strains of seed as there is in improved breeds of live stock. Every tobacco grower for example, wants the most productive and best strains of tobacco seed which it is possible to obtain.

Economic conditions are now radically different from what they were in ante-bellum days. Farming methods which were reasonably effective in those days of cheap land, large plantations, and a plentiful

supply of cheap labor are no longer satisfactory. The cost of living is also much higher and the price of nearly everything the farmer purchases is more costly. In order to achieve success under these changed conditions, farming methods must be placed upon a much more efficient basis.

The above remarks are intended to throw light on the purpose of the experimental and demonstration work which is being conducted at Upper Marlboro, on the Fair Grounds and on the field belonging to Mr. Frederick Sasscer, back of the Chesapeake Beach Railway Station. The experiments at each place are virtual duplications of each other, but they are upon quite different types of soil.

There are three main features to this work:

1. The plot test experiments with fertilizers;
2. The crop rotation demonstration plots, possessing some important experimental features; and
3. The tobacco breeding work which has for its object the securing of better and more productive strains of seed.

The fertilizer plot experiments on each field consist of eighteen-twentieth acre plots, each receiving a different application of fertilizer. Some of the plots contain ammoniates alone, others phosphates and some potash only. There are also plots containing combinations of each two of these fertilizing materials and others containing all three in varying combinations and amounts. It is proposed to duplicate these experiments in succeeding years on different soils and locations, so that finally there will be accumulated for the benefit of tobacco growers a large amount of valuable data as to the very best practice in the use of fertilizers in Southern Maryland. These plots will be carried through the entire crop rotation. The rotation, as at present proposed, covers five years and consists of tobacco, followed by wheat, then grass for two years, followed by corn with crimson clover and then back in tobacco again on the sixth year. From these small plot experiments it is expected to gain very much valuable data as to the efficacy of the combined effect of the different fertilizers used and the crops grown in rotation, on the permanent improvement and fertility of the soil.

These fertilizer experiments include another very important feature. There is a general opinion prevalent that the use of lime on tobacco soils is harmful and prejudicial to the best interests of the tobacco grower by injuring the quality of the leaf produced. On the other hand it is generally known that lime increases the yield of tobacco and is also very beneficial to most of the other crops grown, particularly the legumes and timothy, and all things considered it is perhaps still uncertain whether the use of lime on soils to be used periodically in tobacco is desirable or not. There is also perhaps some ground for believing that the effect of lime on quality and the price actually obtained for the tobacco is not as adverse as is generally supposed. To throw light on this point one-half of each of the fertilizer

plots has been treated to an application of one ton of slaked oyster shell lime per acre. From this experiment there should result a large amount of valuable data as to the real effect of the lime on the quality and yield of the tobacco produced under a great variety of fertilizer conditions. The effect of the lime on all the other crops of the rotation can also be accurately measured. This feature of the experiment alone, if it shows that lime is not as harmful to quality as generally believed, ought to be worth thousands of dollars to the people of Southern Maryland.

Supplementary to these more elaborate small plot experiments there are also on each field a series of five, one-half acre plots on which the proposed rotation will be conducted more nearly upon a field scale, using the best methods known, including those which the smaller plot experiments demonstrate to be best. These plots are designed for object lesson purposes although it is certain that much valuable data will also be obtained under conditions approximately on a field scale, as to the possibilities of Maryland soil under systematic rotation with intensive methods. Aside from an increased yield of tobacco it is expected that there will also result very great improvements in the yield of the other crops, particularly the grass. In experiments similar to these, conducted in Virginia, it was found possible under the system followed to produce really enormous yields of first-class hay instead of the usual almost complete failure under the system generally practiced.

In one case at Appomattox, Virginia, in 1907 the yield was as high as 5.06 tons of cured hay at a single cutting, and the same field again yielded 3.7 tons at the first cutting in 1908 It is believed that many of the soils of Southern Maryland are capable of producing equally good results.

Work for the improvement of the tobacco itself by breeding and seed selection has already been under way in Maryland for several years. It is believed that some improved strains of seed have already been secured, small quantities of which were sent out to about three hundred Maryland farmers this year. This seed work will be actively continued and a portion of both fields at Upper Marlboro are devoted to breeding work, and to testing out on good sized plots the best of the strains and varieties which have been secured. As the years go by we expect to be able to supply growers with small quantities, enough for a start, of constantly improving strains of seed which will be of great value in producing larger and more uniform crop of better tobacco.

The above represents a brief statement of the more fundamental and clearly defined objects of the experiments which are being conducted. As the work progresses, however, there will naturally be many of the more detailed questions of cultivation, combating insect pests, curing, and handling which will incidentally be studied and valuable information secured and published.

In every possible way, so far as the funds available will permit, it is the purpose of those conducting the work to be of service in spread-

ing the gospel of better farming for the tobacco growers of Southern Maryland.

The locations of Upper Marlboro were chosen because of their easy accessibility to all portions of Southern Maryland and it is believed that the two soil types upon which the experiments are located are fairly representative of the soil conditions throughout most of the tobacco growing section.

There is also some work on varieties of tobacco and fertilizers in progress at Chaney in Calvert County, and at La Plata in Charles.

PROPERTY LINES.

For the past 20 years there has been more or less doubt as to the lines of property between the College Park and Lakeland subdivisions and in accordance with your instructions all of the data as to previous surveys has been secured and this was placed in the hands of Edward Latimer, for many years County Surveyor, and he has run the lines and established the corners so that the property can be properly fenced in accordance with your instructions. Two-inch pipe, 3 to 4 feet in the ground, has been placed at all of the angles and stones will be located at the principal points. The fencing of this land will add a considerable area to the pastures and prevent any encroachment upon College property by the development of the above subdivisions.

FINANCIAL CONDITION.

As appears from the report of the treasurer the finances of the Station are in good condition and the year's work has been carried on within the funds available and small balances remain. It has been the general policy of this institution to run on practically a cash basis and contract no debts that cash was not on hand to meet at once. All bills are settled in full at close of each month, and where discounts are allowed for cash in 5 to 10 days they are availed of.

With the improvements in the character of work of all the departments and the general expansion which has been taking place during the past year, the expenses have increased very materially. The increased cost of labor and all materials has also added considerable to the usual calls for money. While larger amounts of money could be efficiently and profitably used, it is felt that the constituency of the Station should be given convincing evidence that the present appropriations are being used to good advantage before asking for any further increases.

HATCH FUND.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATION.

Dr.

1908.

To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1908, as per Act of Congress March 2, 1887..............$15,000 00

Cr.

1908.

June 30,	By	Salaries	$8,835 68
	"	Labor	2,592 00
	"	Publications	5 00
	"	Postage and Stationery	267 27
	"	Freight and Express	456 35
	"	Heat, Light and Water	615 07
	"	Chemical Supplies	35 55
	"	Seeds, Plants and Sundry Supplies	147 38
	"	Fertilizers	52 69
	"	Feeding Stuffs	604 11
	"	Library	114 31
	"	Tools, Implements and Machinery	301 25
	"	Furniture and Fixtures	210 54
	"	Scientific Apparatus	128 97
	"	Live Stock	85 00
	"	Traveling Expenses	418 06
	"	Contingent Expenses	15 00
	"	Buildings and Repairs	114 77
		Total	$15,000 00

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

ADAMS FUND.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE UNITED STATES APPROPRIATIONS.

Dr.

1908.

June 30, To receipts from the Treasurer of the United States, as per appropriations for the fiscal year ended June 30, 1908, as per Act of Congress March 16, 1906...........$9,000 00

Cr.

1908.

June 30, By	Salaries	5,251 31
"	Labor	970 20
"	Postage and Stationery	9 95
"	Heat, Light and Water	113 54
"	Chemical Supplies	426 50
"	Seeds, Plants and Sundry Supplies	106 53
"	Feeding Stuffs	780 48
"	Library	122 54
"	Tools, Implements and Machinery	182 94
"	Furniture and Fixtures	55 78
"	Scientific Apparatus	535 43
"	Live Stock	2 50
"	Traveling Expenses	81 30
"	Building and Repairs	361 00
	Total	$9,000 00

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATE OF MARYLAND APPROPRIATION.

Dr.

1907.		
July 1,	To Cash Balance	$3 52
1908.		
June 30,	To Receipts from State Treasurer: ($5,000 bal. on Appr. of 1907) ($7,500 on acct. of Appr. of 1908)	12,500 00
		$12,503 52

Cr.

1908.		
June 30,	By Repairs	$2,846 27
"	Publications	2,591 57
"	Exhibits	571 78
"	Feeding Experiments	1,927 66
"	Tobacco Experiments	780 60
"	Poultry Experiments	2,020 84
"	Insurance	241 60
"	Trustees' Expenses	266 58
"	Labor	529 40
"	Seed, Plants and Sundry Supplies	70 28
"	Tools, Implements and Machinery	62 15
"	Library	128 70
"	Travel	38 30
"	Balance	427 79
	Total	$12,503 52

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATE OF MARYLAND APPROPRIATION FOR HORTICULTURAL INVESTIGATION.

Dr.

1907.		
July 1,	To Cash Balance	$498 22
Oct. 1,	To Receipt from State Appropriation 1907	4,000 00
1908.		
Apr. 15,	To Receipt from State Appropriation 1908	4,000 00
		$8,498 22

Cr.

1908.		
June 30,	By Salaries	$680 00
"	Labor	439 52
"	Seed, Plants and Sundry Supplies	858 05
"	Travel	233 98
"	Buildings and Repairs	2,392 69
"	Tools, Implements and Machinery	643 52
"	Freight and Express	96 29
"	Postage and Stationery	40 36
"	Fertilizers	49 68
"	Library	12 00
"	Furniture and Fixtures	54 89
"	Heat, Light and Water	42 85
"	Balance	2,954 39
		$8,498 22

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE STATION FARM.

DR.

1907.		
July 1,	To Balance	$1 20
1908.		
June 30,	To Sales of Stock and produce during year	5,766 59
		$5,767 79

CR.

1908.		
June 30,	By Labor	$3,677 37
"	Freight and Express	18 48
"	Seeds, Plants and Sundry Supplies	568 12
"	Tools, Implements and Machinery	887 22
"	Travel Expenses	50
"	Feeding Stuffs	604 71
"	Balance	11 39
		$5,767 79

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

MARYLAND AGRICULTURAL EXPERIMENT STATION IN ACCOUNT WITH THE BUILDING FUND.

1907.

Dr.

	Jan. 1, To State Donation	$5,368 05

Cr.

1907.		
	June 30, By disbursement for erecting the Station Barn	$2,814 47
1908.		
	June 30, By disbursement for erecting the Station Barn	2,552 45
	By balance	1 13
		$5,368 05

The above is a true copy from the books of this office.

(Signed) JOSEPH R. OWENS,

Treasurer Maryland Agricultural Experiment Station.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 119. JULY, 1907

GREENHOUSE PESTS OF MARYLAND.

By A. B. Gahan.

The production of cut flowers and vegetables under glass is a most important branch of horticulture in Maryland. The United States census report for 1900 shows the total area under glass in this State at that time to be 1,195,000 square feet, and the total value of the products from this area is given as $354,000. In the seven years since that time the industry has developed rapidly, many additions having been made to old plants, and some new ones established, so that the area now devoted to this branch of horticulture will doubtless approximate 1,500,000 square feet, with a corresponding increase in the value of the output.

Of necessity, the production of flowers and vegetables under glass is an expensive process, involving not only a large outlay of capital in the first place, but a continual expense for labor, fuel, water, fertilizers, etc. Consequently, anything which interferes with the fullest and best development of the plants reduces the profits in just that much. One of the most serious drawbacks to the successful commercial culture of greenhouse plants is to be found in the numerous insect pests which have to be combatted.

A greenhouse affords an almost ideal environment for the development and rapid multiplication of certain kinds of insects, and, as a consequence, we find a long list of these pests taking advantage of the opportunity offered, and often doing great damage to many of the principal crops grown in houses. The florists and gardeners are compelled to wage a continual warfare against them in order to avoid serious loss. This necessitates a considerable expense, and in some cases is only partially successful in lessening the damage. Hundreds of dollars are expended every year for expensive insecticides, which at best only afford temporary relief.

Considerable has been written upon the subject of greenhouse pests in various periodicals and other publications, but this material is for the most part in such scattered form as not to be readily accessible to the growers. Most of the insect pests have been described at different times, and considerable material has been published regarding the economic treatment of them. In many cases the life histories of these insects have been but poorly understood, owing to the fact that the different stages in their life cycles are so merged together, and

the different generations so poorly defined, that it is extremely difficult to determine them accurately. In this bulletin the author has endeavored to bring together what is known of the life histories and economic treatment of the species occurring in Maryland greenhouses, supplementing this with some personal observations and experiments. Notes were taken, and studies made, of the life histories of several of the species, but in the case of others it was found impossible to obtain specimens that could be isolated and studied.

The list of pests herein treated includes only those that have actually been found by the writer, but it is believed that all of the more important ones common to Maryland greenhouses are covered. The treatment for so many of these pests must, of necessity, be the same, that in order to avoid needless repetition it was deemed advisable to take up the subject of remedies as a distinct subject, rather than to treat the remedies for each individual species of insect separately. In the latter part of this bulletin, therefore, will be found a more or less full discussion of greenhouse insecticides, under the head of "Remedies for Greenhouse Pests."

MEALY BUGS.

Mealy bugs are probably the most universally distributed and well-known of all greenhouse pests. No florist, and but few housewives, attempting to maintain a window garden, but are familiar with them, to a greater or less degree. Two species occur in Maryland, but the commoner one is Pseudococcus citri, Risso. Pseudococcus longispinus, Targ. is not infrequently met with on both indoor and outdoor plants, but is not as conspicuous a pest as is P. citri.

Pseudococcus citri, Risso.

This mealy bug, in the adult form, is about 4mm. in length and 2mm. in width, oval or elliptical in outline, with a fringe of short spines encircling the body. These spines are thirty-four in number, and of about equal length, those on the anal end of the body being slightly longer than the others. The body is covered with a white waxy mass, giving the insect its common name of *mealy bug*. If this wax is removed the body is seen to be of a brownish color.

The female lays from 300 to 500 eggs, depositing them in a mass beneath the tip of the abdomen, and covering them with cottony wax filaments. As the mass of eggs increases in size, owing to the deposition of more eggs, twenty to thirty being deposited every twenty-four hours, the body of the female is gradually tipped upward, until it finally assumes a position almost perpendicular to the surface of the leaf or twig. Egg depositing continues for from a week to ten days, and when it is finished nothing is left of the insect except a shrunken and dried-up skin. The eggs hatch in about two weeks from time of deposition, those first laid hatching first, so that there is a dif-

Plate 1—Coleus plant, showing egg-masses and adults of the mealy-bug (*Pseudococcus citri*).

ference of several days in the ages of the larvæ from the same batch of eggs. The larvæ resemble the adults in appearance, except that, when first hatched, they are quite small, and not covered with the white, waxy filaments. They remain in the mass of waxy secretion with which the egg mass was covered for several days before crawling out upon the plant to begin feeding. Owing to the difference in time of hatching of the eggs, considerable difference is noticed in the size of the larvæ from the same batch of eggs, and it is usually possible to find insects of all sizes and ages upon the plant at any time. Their development is rather slow, it requiring about six weeks to two months for them to reach the adult. Most of this time is spent on the underside of the leaves, sucking the juices from the plant by means of a slender sucking tube, which is inserted into the tissue along the midrib and veins.

A few weeks after the eggs have hatched small masses of the filamentous matter will be noticed on the under side of the leaves, usually a short distance from the veins of the leaf. These are the pupæ of the males. The males are small, winged insects, very slow and awkward in their flight, and not readily observed, because of their color, which is a kind of olive brown. They appear and mate with the females when the latter are about half grown.

Pseudococcus citri is distributed over the greater part of the globe, and is one of the most general feeders of all insects, it infesting and damaging a good many outdoor plants in the warmer latitudes, as well as a long list of greenhouse plants. Of greenhouse plants, the coleus, geranium and sago palm seem to be its favorite food plants, but it is often found on many others.

Pseudococcus longispinus, Targ.

This species of mealy bug, as has been said, while quite common in Maryland greenhouses, does not seem to be as abundant as P. citri. It is readily distinguished from that species by the length of the spines at the anal extremity of the body, the last two of which are as long as, and sometimes longer, than the body. In its life history and habits it is so nearly identical with the foregoing species as to render unnecessary any separate treatment, while its food plants are fully as numerous, and many of them the same.

OLEANDER SCALE.

Aspidiotus hederae, Vall.

This scale is one of the commonest found upon greenhouse plants, and is distributed over most of the world. For some reason entomologists have been very greatly confused on this species, it having been described by different persons under no less than thirty different names.

The female scale is circular, nearly white, very slightly convex, and has a pale orange-colored exuvia in the center, or slightly to one

Plate 2—Leaf of Sago Palm, showing bad infestation with Oleander scale (*Aspidiotus hederae*).

side. The first cast skin usually shows the segmentation of the body. The second is more or less covered with a waxy secretion, and appears as a ring around the first. The body of the female is light yellow. The male scale is white, slightly elongate, and has a central exuvia of light yellow.

The eggs of the oleander scale are light yellow, and quite large. They are deposited beneath the female scale, and hatch in a few hours, the young settling either on the leaves or stems. From egg to adult in this species requires between 70 and 80 days, so that in a conservatory several generations are produced in a year. The generations, however, run into each other so that specimens of all stages may be secured from an infested plant at the same time. The young scales seem to prefer to remain near the parent, and consequently they will often be found in clusters, giving to the bark or leaf the appearance of being covered with a thin white film.

A wide range of plants are attacked by A. hederae, both in the greenhouse and outside. Cycads, palms, citrus trees, orchids, and cyclamens are most often found infested.

A CYCLAMEN AND LANTANA SCALE.

Asp. Lataniae, Signi.

Aspidiotus lataniae is a foreign species, probably introduced into America on imported plants. So far as is known, it is purely a green-house species in this country.

The female scale is somewhat elongate, quite convex, with the cast skin or exuvia a little to one side of the center, and of a bright yellow color. The remainder of the scale is dirty grayish, with a faint yellowish tinge, due to the fact that the yellow body of the insect underneath shows through the thin waxy scale. The scale of the male is similar to that of the female, but smaller.

The scales are almost always thickly crowded together, rather than isolated, and are not likely to be very conspicuous, as their color usually agrees quite closely with that of the host plants. The color seems even to vary somewhat with the host, specimens found on cyclamen bulbs being considerably darker than those found on palms. The species confines its attacks almost entirely to the twigs and trunks, rarely ever being found on the leaves. Upon palms it is more frequently than otherwise found beneath the remains of former foliage leaves around the stem. Not infrequently a plant will be quite badly infested beneath these fragments of the old leaves without showing on the surface.

The young of Asp. lantaniae come into the world as small living scales, instead of eggs, and fix themselves in close proximity to the mother scale. There is no well-defined distinction between broods, scales of all sizes being found upon the same plants, but it is probable that three or four generations are produced in a greenhouse each year.

Aspidiotus lataniae is known to attack Cycas revoluta, Laurus, palms, citrus trees, cyclamen, Lantana and Areca lutescens. Probably other plants also act as hosts, but the above list includes those most liable to attack.

THE GREEDY SCALE.

Aspidiotus rapax, Comst.

The greedy scale is so called because of the large number of plants which it infests, but as it is a semi-tropical insect it attacks only a few plants grown in greenhouses in the latitude of Maryland. The author found it in one house only, where it was infesting specimens of Laurus.

The female scale is very convex, of a grayish white color, or sometimes tinged with yellow, by reason of the body of the insect showing through the more or less translucent scale covering. The exuvia is a little to one side of the center, and consists of a dark, almost black spot, and a concentric ring of white. A well-developed and pure white ventral scale is present.

This species reproduces by eggs, the same being laid beneath the scale of the female. The young settle upon the trunk and branches of the host plant, and will usually be found grouped closely together, rather than as isolated individuals. So far as could be ascertained from the literature on the subject, the life history of this species has never been thoroughly worked out, and unfortunately it was impossible to secure specimens with which its life cycle could be studied. The generations are very poorly defined, as shown by the occurrence of individuals of all ages upon the host plant at the same time. This fact indicates that breeding is almost continuous, i. e., that the females of one generation continue the production of young up to the time that the first hatched individuals of the new generation reach maturity. No doubt in greenhouses the species produces at least three or four generations in a year, and possibly more.

The following plants are liable to attack by this scale: Laurus, orange, lemon, Fuchsia, Camellia, fig, etc.

THE CIRCULAR SCALE.

Chrysomphalus Aonidum, Linn.

Of all the species of scale found in greenhouses, this one is probably the commonest and the best known. It is world-wide in its distribution, and in semi-tropical regions is a serious pest of outdoor plants, but throughout the greater part of the United States it occurs only on plants growing under glass.

The scale of a mature female is comparatively large-sized, almost circular, quite convex, and with a nipple-like prominence in the center, which is grayish, and surrounded by a reddish brown ring. With the

exception of this small central portion the scale is very nearly black, fading out to grayish toward the margins. The scale of the male is smaller, of the same color as the female, but slightly elongate, the posterior margin being extended into a kind of flap, which is distinctly grayish, and embraces about one-third of the circumference of the scale.

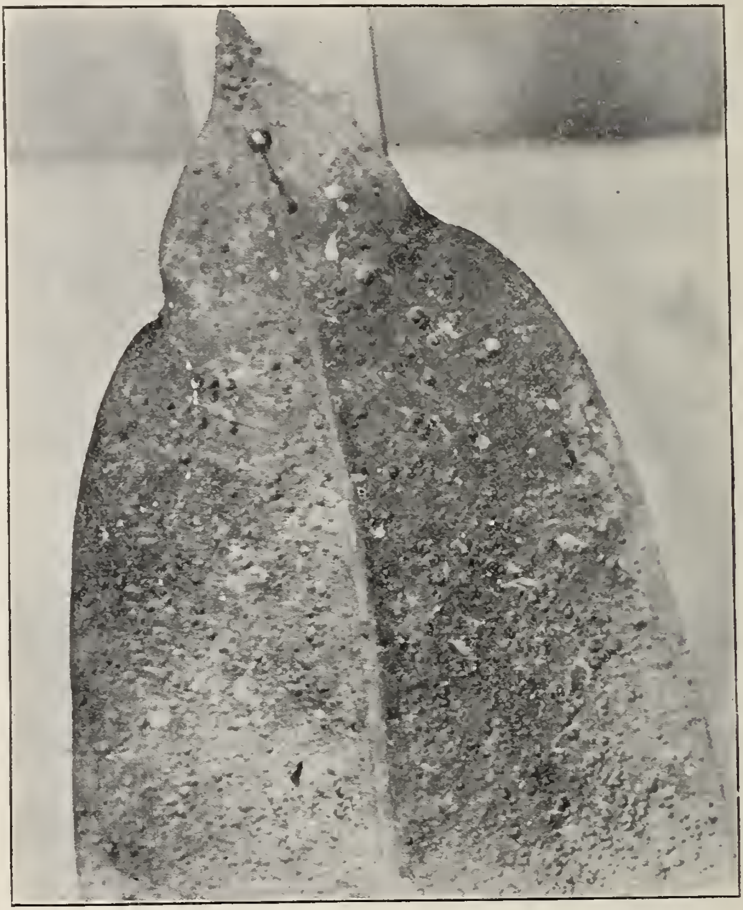

Figure 3—Leaf of Ficus elasticus, showing very bad infestation with the Circular Scale (*Chrysomphalus aonidum*).

The individuals of this species are almost always isolated, and this, with their dark color, makes them quite conspicuous. They occur only on the leaves, infesting both the upper and lower sides. A rather remarkable feature of this scale insect is that, unlike nearly all of the other armored scales, it does not remain fixed after it begins to secrete

its scale covering. The young scales hatch from eggs deposited under the scale covering of the female, and, after crawling a short distance away from the mother, insert their beaks, and begin to secrete a scale covering, which is at first white, but gradually becomes darker as the insect increases in age. After a time the young insect apparently exhausts the supply of food at that place, and then it moves a short distance forward to new pastures. During the life of an insect it probably changes its position several times, although the aggregate distance traveled is rarely more than one inch. A yellow or dead streak in the surface of the leaf is left behind as the insect moves forward, showing where the sap has been exhausted, and the tissue killed.

About six generations of this species may occur under greenhouse conditions in a period of a year, the life cycle being completed in from sixty to seventy days. The female continues oviposition for about twenty days, and in that time produces in the neighborhood of two hundred eggs.

Chrysomphalus aonidum attacks principally those ornamental plants having fleshy leaves, for example: Palms, Cycads, Ficus, citrus plants, oleander, etc.

THE CHAFF SCALE.

Parlatoria pergandii, Comst.

This scale was first described by Professor Comstock, in the United States Department of Agriculture Year-book of 1880, as occurring in Florida upon citrus trees. It is now quite commonly found infesting this class of plants growing under glass. The scale of the female is a dirty gray in color, usually slightly longer than broad, with the cast skin or exuvia at one end. The first cast skin is small and bare, the second considerably longer, covering about a third of the length of the scale, and has a covering of waxy secretion. The male scale is long and narrow, with the lateral margins nearly straight and quite prominent. The exuvia is at the anterior end, quite large and somewhat darker colored than the remainder of the scale, which is light grayish. The larvæ are purplish in color, as are also the eggs, which are deposited beneath the female scale, where they hatch in a very short time.

Apparently the females of this species are not as prolific as those of some others. However, the life cycle is short, covering from six weeks to two months, and, consequently, the scale increases quite rapidly during a season. The young settle upon the trunk and branches mainly, though sometimes they may be found on the leaves. Owing to close resemblance in color to the bark of orange and lemon, the scale is easily overlooked, and may cause considerable injury before noticed. It is not, however, a very destructive species.

So far as known its work is confined to the citrus trees entirely.

THE EUONYMUS SCALE.

Chionaspis euonymi, Comst.

This species is not of any great importance to the greenhouse florist, inasmuch as its favorite food plants (the different species of Euonymus) are not extensively grown under glass. It was found by the writer in a greenhouse near Baltimore, badly infesting several specimens of Euonymus japonica growing in pots, and used for decorative purposes, however, and is included here for that reason.

The female scale is very narrow, almost pointed at the anterior end, and beginning at about a sixth of its length from the front widens rapidly posteriorly, frequently attaining a width near the rounded posterior equal to its length. The scale is firmer in texture than is usual in the genus, quite convex, and dark grayish brown in color. The ventral scale is complete, but unattached posteriorly. The scale of the male is long and narrow, with parallel sides, and three ridges or carinae running lengthwise, and a yellow exuvia at the anterior end. The eggs of this insect are laid beneath the mother scale, are of a purplish color, and very numerous. Under outdoor conditions they hatch about May 15 to the first of June, and probably produce two generations in a season. Under greenhouse conditions, however, it is possible that a third generation may occur.

The writer has never found the species upon anything except Euonymus, but it is said to infest lemon, orange and althea. It is a serious pest of Euonymus, often killing the branches, and sometimes the whole plant, in a single season.

THE ZAMIA SCALE.

Aulacaspis zamiae, Morg.

Aulacaspis zamiae has only twice been recorded as occurring in America—once by Dr. Felt, of New York, and once by King, of Massachusetts. In each instance it was greenhouse plants that were infested. The insect is undoubtedly an imported species, probably being brought in on Cycads from Bermuda. It has only come to the writer's notice in one instance, that being on a specimen of Cycas revoluta, which was in storage in a greenhouse in Baltimore.

The scale is circular, very convex, pure white in color, and frequently has the sides fluted or corrugated. The exuvia is lateral, elliptical in shape, the first larval skin being within the marginal limits of the second, and placed anteriorily. The scale covering is quite tough and leathery, much more so than is commonly the case with the armored scales. The ventral scale is well developed.

The insects were all found on the underside of the small leaflets of Cycas revoluta, and generally in isolation, rather than grouped. In this habit the species differs markedly from Aulacaspis rosae, which

it otherwise resembles. The pure white color, marked convexity, and the above-mentioned habit of isolation make the species quite easy to distinguish from any other likely to be found infesting greenhouse plants.

Only three plants have yet been named as hosts for the species, viz., Zamia villosa, Zamia integrifolia and Cycas revoluta.

THE BLACK SCALE.

Saissetia oleae, Bern.

This is another very widely distributed scale, being found in nearly all parts of the world. In the warmer climates it infests outdoor plants, but in our latitude, and throughout most of the United

Figure 4—Palm leaf infested with Black scale (*Saissetia oleae*).

States, it occurs only as a greenhouse pest. It is not particularly destructive, but often occurs in great numbers, and always accompanied by a black fungus, which lives upon the honey dew excreted by the insects, thus rendering the attacked plant very unsightly in appearance.

The scale is quite large, slightly longer than wide, and quite convex, with a prominent ridge or carina down the middle of the dorsum, and two transverse ridges, the three ridges forming a rough imitation of the letter "H." The sides of the scale are quite flaring, and more or less corrugated. Altogether, the dorsum presents a very rough appearance. In color this scale is very dark brown to almost black.

The females of this species seem to be more than ordinarily prolific, even for scale insects. Dr. Coquillet reports having counted as high as 2,200 eggs and young larvæ from a single female. It is probable, however, the average number will be somewhat less than this, as out of a dozen specimens examined by the writer, in no case were over 1,200 eggs found, and usually less than that. The first eggs begin hatching, however, sometime before ovipositing is finished, and therefore it is possible for a considerable error to be made in estimating the number of eggs actually produced. The young, after hatching, remain for a short time beneath the mother scale, and then crawl out and begin feeding. Unlike most other coccids, this species never, or at least not until quite late in life, loses the power of locomotion, but is able to change its location at will. They feed either upon the leaves or stems; palm leaves have been observed almost completely covered with them, and the dirty black fungus which accompanies them. Happily, the life cycle of this insect is a long one, one generation requiring almost a year to complete its cycle. The egg-laying period for a single female stretches over several months, and the hatching of her eggs covers a like period, so that one will find crawling larvæ upon the plants at almost any time. For this reason it is extremely difficult to obtain accurate data in regard to the exact length of any period of the insect's life.

The black scale is by no means as general a feeder in the greenhouse as some of those previously mentioned. It confines its attacks principally to the citrus trees and palms, but may, at times, be found infesting rose, oleander, Ficus, Euonymus, Cycas revoluta, and possibly others.

THE HEMISPHERICAL SCALE.

Sassetia hemispherica, Targ.

This scale is one of the commonest found upon greenhouse plants. It takes both its popular and scientific name from its shape, which more nearly approaches that of a hemisphere than any other scale. The outline of the body is slightly elliptical, i. e., somewhat longer than broad, varying to some extent with its position. Upon the twigs or stem it is apt to be more elongate, with the edges flattened and bent to conform to the shape of the twigs. The back is very convex,

smooth or slightly wrinkled, and shining. The color varies from a light brown to a dark brown, and often nearly red.

This species is oviparous, the eggs being deposited beneath the body of the female. The under side of the female gradually shrinks as the eggs are deposited, until, when oviposition is finished, and the female dies, nothing remains but the hard outer shell, which is almost completely filled with eggs. The young, upon hatching, go to the leaves and settle there along the mid-ribs and veins, where they remain for a period of four to six weeks, when they migrate back to the stems, and there settle permanently. Under greenhouse conditions the life cycle in this species is completed in five to six months, allowing the development of two complete generations in a year. A single female may produce from five hundred to a thousand eggs, most of which hatch, but of course only a small proportion of the young establish themselves successfully upon the plants. Unlike some species of this genus, the eggs from a single female all hatch at about the same time.

The food plants of this species are almost as numerous as those of Coccus hesperidum, and hemispherica is fully as troublesome as is that species. Its favorite host plants are ferns and crotons, but it also attacks chrysanthemums, orange, palms, orchids, camellia, guava, salvia, rose, oleander, abutilon, Cycas revoluta, alternanthera, and probably other greenhouse plants.

THE SOFT SCALE.

Coccus hesperidum, Linn.

This scale gets its popular name of the soft scale from the fact that its shell is soft and easily crushed. It is one of the most widely distributed of scales, being found practically all over the world. The young are small, elliptical and flat, almost colorless creatures, hardly distinguishable from the leaves upon which they are found. The color changes gradually with age. The adult scale is dark brown, or almost black, somewhat longer than wide, quite convex, and with a prominent ridge running lengthwise down the middle, and two transverse ridges running nearly to the margins. The margin of the scale is somewhat flattened, and marked with many small transverse ridges running to the edges, and usually it has two more or less well-defined notches on each side, opposite the ends of the large transverse ridges, and a less conspicuous one at the rear end. The scales are usually accompanied by the black fungus growth, common to this and related genera, and which grows upon the honey dew secreted by them, giving to the surface of the infested leaves a dirty and unsightly appearance. Certain ants are very fond of this honey dew, and not infrequently infested plants will be found with little groups of ants gathered about individual scales, enjoying the dainty feast. Where ants are plentiful the fungus is generally absent. Whether the ants in any way protect or spread the scale I do not know.

The insect is viviparous (i. e., the egg stage is lacking). The young usually remain under the body of the female for several days, then crawl out upon the leaf, and establish themselves along the mid-rib or veins, or sometimes on the young growth of the stem. In greenhouses, breeding is continuous, several generations being produced in a year. A female produces young during a considerable period, scales of all sizes and ages being found on the plants at the same time.

The food plants are numerous, embracing nearly all types. Begonias, crotons, palms, Ficus, cyclamens, anthuriums, all citrus plants, Euonymus, roses and calla lilies constitute a partial list.

THE LONG SCALE.

Coccus longulus, Doug.

Coccus longulus is a very widely distributed scale, being found in many parts of the world besides America. It infests both outdoor and indoor plants in warm climates, but is confined to hot-houses and conservatories farther north.

The scale is about twice as long as broad, rather flat, rounded at both ends, and with the dorsum perfectly smooth and shining. In color it varies from light brown to very dark brown. The young are nearly colorless at first, of about the same shape as the adult, but small, and provided with legs. They usually fix themselves close to a mid-rib or vein of the leaf, though quite frequently they may be found on the upper sides of the leaves.

The list of food plants is a long one, but not as long as that of Coccus hesperidum. Its attacks on greenhouse plants are usually confined to the Ficus, Euphorbia, citrus trees, Albizzia and ferns.

THE BLACK APHIS OF CHRYSANTHEMUM.

Nectorophora chrysanthemicolens, Will.

The black aphis, or "black fly," as it is erroneously called by most florists, is too well known to warrant a detailed description here. Wherever chrysanthemums are grown it will be found sucking the sap from the stems and leaves. The insects gather about the terminal buds upon the young growth, and, if neglected, soon become so numerous that the growth of the plant is completely stopped. The rate of increase is almost incredible, and has led some growers to believe that the pest is a product of spontaneous generation. Some observations taken by the writer will serve to illustrate the remarkably rapid rate of increase in this species. Young agamic (that is, non-sexual) females isolated upon separate plants, began producing young in every case within eight days after birth. Each female produced from four to sixteen young lice per day, and the average number produced by each

Plate 5—Chrysanthemum infested with black aphis (*Nectorophora chrysanthemicoleus*).

was about two hundred. These young lice all insert their beaks, and begin drawing sap almost immediately after birth, and without wandering far from the mother aphis, unless crowded for room, when they move away to a place where they will not be interfered with, which may be lower down the stem, on the under side of the leaf, or upon a new plant. It can readily be seen from the figures above that the number of lice upon a plant, which has been neglected for two or three weeks, will be something enormous, even with but one female on the plant to start with. Winged females are produced at intervals, and these fly to other plants and bring forth young in the same manner as the wingless form, that is, without the intervention of the egg state. It is not known how long this reproduction of the species agamically can continue under greenhouse conditions, but it is certain that a sexual form of female is produced at intervals which, after mating with the males, produces eggs from which agamic females again appear, and give birth to living young.

So far as known to the writer, N. chrysanthemicolens attacks no other plant than the chrysanthemum. Other species of black aphids occur in conservatories, notably upon the rose and violet, which are often mistaken for this one, but which are distinct species.

THE GREEN APHIS OF THE ROSE.

Nectorophora rosae, Linn.

The green aphis of the rose is one of the greatest drawbacks to successful rose culture in greenhouses. It is found attacking the leaves and young twigs wherever the rose is grown, and occasions the florists considerable expense and labor in its control. The species was originally described from Europe. Some doubt exists as to whether the European species and our own are identical, but most writers who have treated the subject have considered them as the same.

The following description of Nectoropora rosae is taken from Thomas' Eighth Report on the Noxious and Beneficial Insects of Illinois:

"The wingless viviparous female is about one-eighth of an inch long, of an elongate ovate form; shining green or reddish, antennae as long, or longer, than the body; honey-tubes long, reaching beyond the tip of the abdomen; tail prominent, yellow; eyes red, legs long, yellowish green, with black knees and feet. The winged female has the head and thorax shining black; eyes red; antennae longer than the body, dark; abdomen green, with about five black dots on each side in advance of the honey-tubes, and usually two short transverse black bands behind them; tail yellow, hairy; wings large, sub-costal vein yellowish, other veins dark, stigma greenish, honey-tubes black."

The winged form is rarely seen, practically all reproduction being carried on by the viviparous form. Breeding in this form is extremely rapid, one female producing from four to ten young per day, and it

requiring but eight days to two weeks for these young to reach maturity. It is surprising how soon plants will become reinfested after a fumigation that apparently killed all but a few scattering individuals.

Figure 6—Twig of rose, showing infestation with the Rose aphis (*Nectorophora rosae*).

Three or four weeks suffice to reinfest them almost or quite as bad as before the fumigation. The favorite part of the plant for these aphids to feed upon seems to be the extreme ends of the new growth or the flower buds. They not infrequently become so thick about the buds as almost to cover them, and when this occurs the bud is rendered worthless. In most of the essential points of its life history this species closely resembles the chrysanthemum aphis.

So far as known to the writer its attacks are confined to the rose plant.

THE MELON APHIS.

Aphis gossypii, Glov.

This plant louse is a well-known enemy of outdoor grown plants, especially those belonging to the Cucurbitaceae, and has been mentioned frequently as a pest of greenhouses as well. It is a general feeder, affecting many weeds and garden vegetables, besides the Cucurbits. In greenhouses the writer has found it only upon cucumbers, begonias and an Hibiscus, but it doubtless affects many others also. Like other similar species it is known to florists and gardeners as "green fly," no attempt being made to differentiate between it and other greenish-colored species of Aphididae. The color of the species varies greatly, ranging from almost yellow to nearly black, but the prevailing color noticed by the writer is a more or less purplish green. Like the other aphid pests of greenhouses, this species increases very rapidly, and if neglected soon injures its host. The lice confine themselves principally to the under side of the leaves of the cucumber, but those found upon the begonias and Hibiscus were attacking the flower buds and terminal shoots of the plant, and entirely ignoring the leaves. The life history is practically the same as that of the chrysanthemum aphis, both winged and wingless agamic females being produced, and a generation of sexual individuals developing at intervals. The females possessing wings are much more numerous in this species than for any of the others found in greenhouses.

In addition to the plants already mentioned as hosts for aphis gossypii, Mr. Chittenden, of the United States Department of Agriculture, reports these greenhouse plants as subject to attack: Ground ivy, hydrangea, Acalypha, bean and beet.

THE BROWN APHIS OF THE VIOLET.

Rhopalosiphum violae, Perg.

The brown aphis of the violet, although at present a very widely distributed species, had received but little, if any, attention prior to 1894, when it was first described and named by Mr. Pergande, from specimens collected at Garrett Park, Maryland. The species is sufficiently distinguished from the green aphis affecting the violet by its color, which is dark brown, both in the winged and wingless forms. The winged form is still more easily recognized, because of the dark-clouded venation of the wings. The insects are generally found on the stems of the leaves well down towards the crown, where they are not readily seen, and where they are difficult to reach with any kind of spray. Their injury is rather a stunting of the plant, causing it to produce weakly and imperfect flowers, than the actual killing of it.

In this species, as with other aphids, breeding is so rapid as to seem almost incredible. In no point of its development does it differ materially from the foregoing species. Winged agamic females, which produce agamic young, and enable the species to spread, are developed at intervals, but seemingly without any regularity, appearing to depend more upon circumstances as regards food than upon anything else. When a plant becomes so completely infested as to cause crowding among the insects, the winged females appear, and in this way enable the species to survive. As the wingless individuals are unable to spread to new food plants, to any extent, but must remain upon the plant where born, some such provision as the winged female is necessary. Otherwise the insects would become so numerous upon the original plant as to kill it, and thus the species would exterminate itself. A sexual generation no doubt occurs also, but has not been observed.

The species occurs on no other plant than the violet, so far as known.

WHITE FLY.

(*Aleurodes citri*), Riley and Howard.

This pest is well known to most florists, and is one of the most troublesome insects that they have to contend with.

The insect is a sucking one, belonging to the order Hemiptera, or true bugs. It is very small, being only about one-twentieth of an inch in length and twice that in wing expansion. The wings, which are the most conspicuous part of the body, are pure white, giving to the insect its popular name of white fly. The body is yellow. The larvæ are much smaller, wingless, pale greenish-yellow in color, with two yellowish spots on the upper side of the abdomen, and their eyes, of which there are four, are red. In this stage a white fly somewhat resembles a young mealy bug, except that the margin of the flat body lacks the spines of the Pseudococcus larvæ.

The eggs of the white fly are deposited on the under side of the leaves, and are very minute, yellowish green in color, and attached by means of a slender pedicel or stem. The surface of the egg is smooth and shining. About 20 to 25 eggs are laid by each female, hatching in from ten days to two weeks. After hatching the larvæ, after crawling a short distance, attach themselves to the under side of a leaf, and begin sucking the sap. They remain attached until full grown, when the winged adult emerges, and it also derives its sustenance by sucking the sap from the leaves. The complete life cycle requires a period of about six weeks, and thus it will be seen the insects increase very rapidly.

The presence of the pest is easily detected. Though very small, the adults are quickly seen, owing to their conspicuous white wings. They take flight at the least disturbance of the plant upon which they are feeding, and, if numerous, will sometimes arise in clouds. Badly

infested plants wilt down, owing to the loss of sap. Examination of these wilted plants will generally show them covered with a dirty-colored fungous growth, which is induced by the presence on the leaves of a sticky secretion from he young bugs.

A list of food plants would include very many of the principal plants grown under glass. Professor Britton, of Connecticut, reports having found eggs upon 58 different species of plants, some of which were growing out of doors. Its favorite food plants, however, among those grown under glass, seem to be tomatoes and cucumbers. Geraniums, chrysanthemums, heliotrope, rose, primula, lantana, salvia, fuchsia, aster, coleus, bean and lettuce are also subject to attack and severe injury by it.

RED SPIDER.

Tetranychus bimaculatus, Harvey.

Notwithstanding its popular name, this pest is in reality not a spider at all, but a tiny mite belonging to the family Tetranychidae. It was first described and named by Professor Harvey in the annual report of the Maine Agricultural Experiment Station for 1892. Up to that time all the spinning mites (with the single exception of one occurring on oranges) had been indiscriminately referred to as belonging to a single species, Tetranychus telarius, a common species in Europe. In 1900 Mr. Nathan Banks, after careful study, recognized ten distinct species as belonging to the genus Tetranychus (Technical Bulletin, No. 8, United States Division of Entomology). He found T. telarius infesting outdoor plants, but was convinced that the common mite of greenhouses was, as Professor Harvey had said, a different species from the European one, and he retained the name given by Professor Harvey, T. bimaculatus. The error of previous authors in considering all of the spinning mites as belonging to a single species undoubtedly arose, for the most part, from depending merely upon superficial characters for their identification.

For the purposes of this paper it will not be necessary to go into a detailed and technical description of T. bimaculatus, since apparently only the one species is likely to be found on greenhouse plants. In some respects the name red spider is a misnomer, as the mites vary in color from pale pinkish to almost black, depending upon the age and food plants of the individuals. Some specimens are even greenish, with two or more darker spots on the back of the abdomen. They are extremely small, though visible without the aid of a glass, but are likely to be overlooked until attention is called to them by the injury to the plants. Attention is sometimes drawn to them by reason of the thin white web which is spun on the surface of the leaves, but it is usually only in cases of bad infestation that the web becomes apparent. The injury to the leaves is quite characteristic. The leaves of an infested plant first become dotted with brownish patches, usually on the under side, and then gradually wither and dry up.

The eggs of the mite are deposited on the underside of the leaves, from five to ten being laid each day, and one female will lay from 80 to 100 eggs. These hatch in three or four days, under favorable conditions. Observations indicate that in a greenhouse three to four weeks are sufficient for the completion of a life cycle. It will thus be seen that the rate of increase will be something enormous, if the mites are left undisturbed. Fortunately, the ordinary methods of caring for plants under glass destroy large numbers of them, and thus partially hold them in check.

The list of food plants of the red spider is a long one, including many of the common greenhouse plants. The carnation, rose, geranium and violet are especially liable to attack, however, and it not infrequently causes great damage to these plants. Probably the rose and carnation growers are the greatest sufferers, it sometimes occurring that even well-cared-for houses become so badly infested as to render the crops of these flowers almost valueless, owing to the stunted condition of buds which have been robbed of their natural nourishment.

THRIPS.

Carnations are not infrequently badly damaged by tiny insects called thrips, which are closely related to the true bugs, or Hemiptera. The thrips work in the flower buds, causing small, irregular white blotches to appear on the petals, and thus rendering them imperfect. In case of bad infestation, the flowers are rendered unsalable, and the florist sustains a heavy loss. The blotches are caused by the sucking of the sap from the petals before the flower is open, causing the tissue to turn white.

The insects are less than a tenth of an inch long, very slender, and in the adult form dark colored, almost black, with four small membranous wings carried flat on the back. The head is quite small, and the abdomen long and slender, giving the insect the appearance of being pointed at both ends. The larvæ are slightly lighter in color than the adults, and have no wings, but otherwise they look much alike. When disturbed the thrips will frequently elevate the tip of the abdomen, as if intending to sting. They are very active, leaping or flying readily, or wriggling out of sight so quickly among the bases of the petals when the flower is torn open that it is very difficult to capture one of them. The life history of the greenhouse species has never been satisfactorily worked out, but it is probable that the eggs are laid in the tissue of the plant in the leaf or stem, as with other species of the genus, and when the eggs hatch the young larvæ crawl out and feed by sucking the sap, as do the adults.

The carnation is the only greenhouse plant liable to be severely injured.

WIREWORMS.

Considerable damage is sometimes done to greenhouse plants by larvæ of certain click-beetles known as wireworms, which feed upon the roots. These larvæ are long, slender, dark-brown creatures, slightly resembling centipedes in appearance, but having only six legs and a head that closely resembles that of the adult beetles. The beetles are dark brown or black, long and slender, and when held in the hand endeavor to jerk themselves loose by snapping their heads violently up and down. The adults are seldom seen about the houses, the larvæ being much more commonly observed.

The larvæ apparently have no favorite food plant, but infest all about alike, their presence seeming to depend somewhat upon the character of the soil in which the plants are grown.

SOW-BUGS.

A rather severe injury to orchids by sow-bugs was observed by the writer recently in a Baltimore florist's establishment. This is another greenhouse pest that cannot be classed as an insect, although the appellation of sow-bug would seem to indicate that it belonged to that class. Its structure, however, places it naturally in a class with the snails, crabs, crawfishes, etc., and it is consequently classed as a crustacean.

The pests are dark gray, oval, flat-bodied creatures, with the body distinctly divided into segments. Seven pairs of legs are borne upon the thorax, one pair to each segment. The abdomen, which is plainly separated from the thorax, bears a pair of inconspicuous rudimentary legs upon each segment, and at the tip are two long, flattened appendages. The sow-bugs are quite active, quickly dodging under the nearest protecting object when exposed to the light.

They are not ordinarily considered as injurious, being more commonly observed in cellars, under decaying wood, or in other damp and secluded situations. The perforated pots, filled with broken pieces of pottery or stones, in which the orchids are grown, furnish an ideal hiding place for them, and the large, fleshy roots of the plants constitute an apparently acceptable diet. The feeding is done at night, the terminals or growing points of the roots being eaten off, and the growth of the plants restricted.

No instance of injury to other plants than orchids has ever come under the writer's notice, and it is probable that their work upon these plants is largely due to the circumstance that the loosely filled pots furnish such an inviting habitation.

SLUGS.

One of the most annoying pests of the florist is the slimy, repulsive-looking creature commonly referred to by the grower as a snail. The creature is not, however, a snail, but is properly called a slug. Several

species are found infesting greenhouses, but the commonest one is probably Limax maximus.

These slugs vary in length from a half inch to three or four inches when adult, are dark colored, sometimes nearly black, often

Figure 7.—Eggs of the greenhouse slug (*Limax maximus*). About natural size.

spotted or striped above, and the body is covered with a slimy mucous secretion, which sticks to whatever the slug crawls over, leaving a trail of glistening slime to mark its path. The head and body are contractile, and upon the head are two contractile feelers, which are

being continually thrust out and drawn in when the slug is in motion. Just back of the head is a broad plate, or mantle, slightly different in structure from the rest of the body. An opening in the margin of this mantle on the right side marks the opening of the respiratory organ.

Little is known of the life history of the pest. The author was lucky enough to secure from a female confined in a breeding jar a batch of eggs, a photograph of which is here shown, but unfortunately was unable to obtain any young from them. The eggs had probably not been fertilized. They were about the size of an ordinary garden pea, semi-transparent, and there were about sixty or seventy of them in the batch. They were all deposited in a compact mass, and were held together by a transparent mucous covering, which enveloped each egg. When the adult slugs are irritated, the flow of the mucous secretion is greatly increased, and this has suggested one method of destroying them. If tobacco dust, air-slaked lime, ashes or soot be sprinkled liberally about the benches among the pots where the slugs will be compelled to crawl through it to get at the plants, the fine particles will be caught up by the mucous covering, and will cause an irritation that will increase the secretion, and as this dries quickly upon exposure to the air, the slug will soon exhaust itself, and become a prisoner, and will eventually die.

Many different kinds of plants are injured by these slugs, they seemingly having no favorite food plants.

REMEDIES FOR GREENHOUSE PESTS.

The handling of the insect pests of greenhouses presents several features not met with in any other phase of insect control. In the first place, most greenhouses contain not one or two kinds of plants only, but a great many different kinds, varying widely in their characteristics, and incapable of withstanding the same modes of treatment. For instance, a house given over entirely to violet culture may be safely fumigated with a strong charge of potassium cyanide, whereas, if a house containing, besides violets, a number of other species of plants, be treated with the same charge, the results would be disastrous. Therefore, some other treatment for the violets in the latter house becomes necessary.

Again, the manner of growing plants in a greenhouse may render impracticable or difficult certain modes of treatment that would be all right outside. In order to economize space, the plants are grown as close together as possible, and often upon benches that can be approached from only one side. Spraying or syringing under such circumstances is likely to be ineffective, owing to the fact that the insects cannot all be reached by the spray. An added disadvantage in spraying or dusting with insecticides in greenhouses is the difficulty of getting about between the benches with any sort of adequate apparatus. A bucket pump or a knapsack sprayer are both unsatisfactory, but about the only instruments available.

The great prolificacy of many of the species, and the fact that breeding goes on the year round with many of them, renders imperative some effort at their control. The purposes of the author will be to put before the florists the best methods of handling the various pests in so far as he has been able to determine the best methods through consultation with experienced greenhouse men, perusal of literature upon the subject, and personal observations and experiments performed with that object in view.

The general subject of insect control in greenhouses may be divided into distinct heads, as follows: Precautionary measures to prevent infestation, syringing with water, fumigation, dipping, spraying and dusting. Under each head will be discussed the different methods and materials used, as well as mention of the pests to which each treatment applies.

PRECAUTIONARY MEASURES TO PREVENT INFESTATION.

Since a greenhouse is closed, and practically isolated from all outside influences, insects as well as others, it seems apparent that infestation with insects must come about in one of two ways, either by the pests being carried into the house on plants, or cuttings, or by their being harbored in the house already from some former crop of their food plants. Both of these conditions are known to exist, and it is probable that infestation is seldom brought about in any other way. This suggests the thought that if the house can in some way be completely rid of insects, and then no plants be taken into it except what are known to be free, much of the trouble of fighting insect pests should be done away with.

There are very few houses, we believe, that are not at least once a year completely cleared of all plants, and many receive such a clearing out between crops more than once. It is the writer's belief that if the growers would take advantage of these opportunities, and fumigate their houses for several hours with a strong charge of potassium cyanide, that they would find their houses much freer of insects for some time to come than is ordinarily the case. Many of the pests, such as red spider, white fly, aphids, slugs, etc., pass the period between crops of their food plants, either upon weeds that may be growing about the place, or concealed in cracks and other hiding places. A thorough fumigation with twenty-hundredths of a gram to a cubic foot, or at the rate of seven ounces of cyanide per one thousand cubic feet of space in the house, would guarantee the destruction of all insect life in it, and leave the house practically clean for the new crop. This treatment would be comparatively inexpensive, and but little trouble. An instance may be cited of a tomato house that was swarming with white fly. The crop having been harvested, the house was thoroughly fumigated in the spring of 1906, just before the vines were removed. The floor of the house was literally covered with dead flies after the treatment. Another crop of tomatoes was started in the house in the fall of the same year, and in March, 1907, not a white fly had as yet

appeared in it, although another tomato house a few yards away was swarming with the pests at that time. In the writer's opinion, although he has not as yet tried it, the carnation houses would be greatly benefited by similar treatment for the red spider. It is understood, of course, that such a strength of cyanide is not to be used in a house where there are growing plants, but only when the crop has been harvested, and the plants are ready to be thrown out. More will be said regarding the use of cyanide for growing plants under the head of fumigation.

After the house has been thoroughly fumigated, and all insect life destroyed, careful attention to see that plants taken into it are free of all pests will be the next thing. This can be accomplished by dipping all cuttings or potted plants before they are taken into the house, either in a strong solution of soapsuds, or a ten or fifteen per cent. mixture of lemon oil or fir-tree oil. No doubt other materials could be used, but they have not been experimented with, and the soap solution is perfectly satisfactory, as well as cheap and simple to make. Any good soap, such as Ivory, will do, and should be used at the rate of about one pound to the gallon of water, the plants being immersed in the solution for at least several seconds, so as to become thoroughly wet in every part. Of course, plants that are grown in seed-beds that are not liable to become infested need not be dipped; otherwise they should be. Mealy bugs, aphids, red spiders, thrips, scale insects and doubtless others may be carried into the houses in the fall upon cuttings, and all except the scale insects can, in the writer's opinion, be practically eliminated by a combination of the two measures suggested. The scale insects can only be kept out by a careful inspection, and throwing out of all infested stock, or by very careful washing of the infested plants to remove the scale.

SYRINGING WITH WATER.

Many florists and gardeners depend almost entirely upon the use of water for the control of insect pests, and where a good pressure of water is obtainable very little else is necessary to keep down most of them. A thorough washing off or syringing once or twice a week will prevent the young from getting a foothold, provided the pressure is sufficient to knock them off the plants. Mealy bugs and young scale insects, if knocked off in this way, are usually unable to regain the host, and will perish, but plant-lice are not so easily destroyed, and even if knocked from the plants, many will succeed in crawling back. However, their numbers may be kept down by persistent syringing, provided the plants are not too susceptible to injury by excessive watering. The greatest drawback to the control of insects by syringing is the fact that in order to wash all of them from the host plant it is necessary to use much more water than is required for an ordinary watering, and too much water is a serious detriment to the plants, in many cases. It will often destroy a delicate flower, and some kinds of

foliage will not bear wetting, so that it is often impossible to syringe sufficiently to destroy the pests. There is little doubt that the red spider can be effectually controlled upon carnations and other plants by the process of syringing, as the mite is partial to a dry atmosphere, being unable to thrive in dampness, but, unfortunately, carnations will stand but little wetting, and hence the mites are often left to breed undisturbed. Upon plants that are not easily injured by wetting the red spider can be kept down by one or two syringings a week.

A good nozzle of some sort is an indispensable aid in syringing, as it not only enables the operator to more effectually cover the plant, but it also greatly increases the force of the stream, and adds to the certainty of dislodging the pests. Any nozzle that permits of regulation of the fineness of the stream or spray is acceptable. It is desirable to be able to reduce the force of the stream when operating upon small, weak plants; otherwise they may be broken or damaged.

Ornamental palms, which are particularly likely to become infested with scale insects, such as the circular scale, the soft scale, etc., may be effectually cleaned by laying each leaf flat upon a smooth surface, and directing a strong stream of water against it for a short time. If the pressure is good the scale will be torn loose and destroyed. A large palm may be cleaned in this way in a few moments. The only requisites are a good pressure, a good nozzle, and a smooth surface upon which to lay the leaf.

Where only a weak pressure is obtainable, syringing is by no means so successful. Mealy bugs, plant-lice, scale insects, thrips, etc., are not injured by water unless washed from the plants, and it is impossible to dislodge them without force. In the absence of a good pressure, therefore, some other means of handling them must be utilized.

FUMIGATION.

Treatment of greenhouses by fumigation in one form or another is, without doubt, the cheapest, most effective, and the least troublesome of all methods where such treatment is possible. It has the great advantage of reaching every part of the infested plants, whereas in many other methods of treatment, notably syringing and spraying, it is next to impossible to avoid missing some parts of the plants. The only insects not affected by fumigation are those that are working inside the plant tissue, or in some other place where the gas or fumes cannot reach them. It is not meant by this that no other insect will escape death in an ordinary fumigation, as it is a well-known fact that some usually do survive. The reason for their escape, however, if the work has been properly done, is to be found in their power to resist the particular fume or gas that has been used, rather than that they have not been reached by it. Unfortunately, there is a limit to the amount of any poisonous gas or fumes which a plant can withstand, and it not infrequently happens that the limit is less than that which will prove fatal to all the insects. Consequently we have some of the pests usually surviving the treatment. Nevertheless, experimentation has

shown that many plants will stand a fumigation with some one of the materials that will prove fatal to most of the pests, and with this class of plants no other method of treatment can be used with as satisfactory results.

Several different materials may be utilized for fumigating, the particular thing to be used depending upon the insect to be combatted, and the kind of plant that is to be treated. The common fumigants are tobacco stems, tobacco punk, tobacco extracts (variously known as Nikoteen, Rose-leaf Extract, etc.), sulphur and potassium cyanide.

Tobacco Fumigation.

The best known and most widely utilized fumigant is some form of tobacco, such as the stems and leaves, or tobacco punk (a proprietary article), which are burned in the houses, the fumes thus generated being depended upon to kill the insects. This is pre-eminently a treatment for aphids, or plant-lice, and is of very little use against any other pest. As a treatment for the plant-lice of roses and chrysanthemums it is quite satisfactory, especially the tobacco punk, but for the aphis of the violet it is a failure, as the violet is injured by the tobacco fumes, which cause a spotting of the leaves. The method has one disadvantage in that it is not as effective against insects infesting plants that are upon low benches, or not elevated at all, as it should be. The fumes are light, and unless used in excessive amounts will not become strong enough near the floor of the house to kill the plant-lice.

The tobacco leaves or stems are either placed on the floor of the house, or in shallow pans on the floor, and allowed to burn slowly, so as to form a dense smudge. The punk may be hung to the benches, or placed upon the floor, as with the leaves and stems. While the punk is more expensive, it is more effective and satisfactory, as it gives off a heavier and stronger fume than can be obtained by burning tobacco leaves and stems.

The tobacco extracts, such as Rose-leaf and Nikoteen, when used as fumigants, are diluted with a given quantity of water, and then vaporized, either by heating over an oil stove, or by throwing hot irons into the pans. The difficulty with this method is that heating over an oil stove does not vaporize the extract fast enough, and it is an impossibility to throw hot irons enough into the pans to completely vaporize all of its contents. What is doubtless a more satisfactory method of producing the vapor consists in using a plumber's soldering lamp to give the heat. With these lamps the flame can be blown directly into the liquid, causing it to vaporize much more quickly than in any other way. When properly vaporized the fumes from the tobacco extracts are fully as effective as those from burning punk, and the treatment is fully as satisfactory. However, fumigation with tobacco fumes of any kind is effective only in controlling aphids or plant-lice. Mealy bugs, red spider, scale insects and white fly are not affected by it, except to a very slight extent.

Fumigation With Sulphur Fumes.

The fumes obtained by burning sulphur are known to be an excellent insecticide under some conditions, but are not safe for use in treatment of greenhouses. However, as a treatment for mildew, in many houses the practice is followed of sprinkling the heat pipes with sulphur, where it is slowly oxidized with the formation of sulphur dioxide, which probably has some slight insecticidal value. The oxidation of the sulphur is too slow to cause the giving off of sufficient sulphur dioxide to hurt the plants, but enough is given off to act as a deterrent, at least to a slight extent, to insect propagation. It is impossible, however, to use sulphur fumes successfully as a direct fumigant, owing to the great danger of injuring the plants.

Potassium Cyanide Fumigation.

The use of potassium cyanide as a fumigant for greenhouses has quite recently been recognized as a practicable and entirely satisfactory treatment, when properly handled, for many pests. For a long time it was regarded as too dangerous to use with growing plants, but careful and repeated trials have demonstrated that it can be used with safety with a considerable number of different plants, and it is probable that properly handled it may be used with nearly all that are grown in greenhouses. The materials are cheap, the process of fumigation not at all complicated, and the results to insects so much more deadly than with any other method of fumigation, that could the florist be entirely certain just what amount of the gas any certain plant would successfully withstand, it would doubtless soon come into general use for combatting certain insects. This is a point that can only be determined by actual and repeated trials, and so far no one has ever taken up this work and carried it through for all the different species of greenhouse plants, although considerable work was done along that line at one time by the United States Department of Agriculture. In the course of the preparation of this bulletin a number of tests were made of different strengths of the gas and times of exposure upon numerous of the more common plants grown under glass. It was found that the amount of the gas which different plants will withstand successfully varies widely. Violets are not injured by an exposure to a charge of fifteen hundredths of a gram per cubic foot of space (or 5.3 ounces to a thousand cubic feet), while Heliotrope and some other plants are unable to withstand a charge of one-fifth that strength. The table on the following page shows the amount of cyanide and the time of exposure that may be used with safety in fumigating a number of the common greenhouse plants.

The results set forth in this table were arrived at by fumigating the plants enumerated with varying amounts of the gas and different lengths of exposure, the fumigating being done for the most part in a tight box. Where possible the test was repeated under actual green-

house conditions, in order to make sure that the effects when the box was used would not be different from the effects in a greenhouse. The amounts given do not represent in all cases the maximum amounts, either of cyanide or exposure, that were given without injury to the plants, but are rather the amounts that are believed to be perfectly safe.

Table showing amounts of potassium cyanide used and length of exposure given to various plants without injury.

Plants.	Cyanide per 1000 cu. ft.	Length of Exposure.	Remarks.
Voilet	4 ozs.	2 hours.	
Primula	1 oz.	Overnight.	
Chrysanthemum	¾ of an oz.	Overnight.	Old plants will stand more.
Begonia	1 oz.	Overnight.	
Nasturtium	1 oz.	Overnight.	
Alternanthera	1 oz.	Overnight.	
Lantana	1 oz.	Overnight.	
Verbena	1 oz.	Overnight.	
Orchid	1 oz.	Overnight.	Tried but once at this strength.
Snapdragon	¾ of an oz.	Overnight.	Tried but once.
Asparagus fern	¾ of an oz.	Overnight.	Tried but once.
Sweet pea	¾ of an oz.	Overnight.	Tried but once.
Coriopsis	¾ of an oz.	Overnight.	
Mignonette	¾ of an oz.	Overnight.	
Carnation	¾ of an oz.	Overnight.	Does not kill red spider.
Croton	2 ozs.	Overnight.	Only two varieties tested.
Cyclamen	2 ozs.	Overnight.	
Easter Lily	2 ozs.	Overnight.	
Geranium	1 oz.	Overnight.	
Rose	1 oz.	Half hour.	
Coleus	1 oz.	Half hour.	
Sago Palm	1 oz.	One hour.	
Acaranthes	1 oz.	One hour.	
Tomato	¾ of an oz.	Overnight.	Tried many times.
Cucumber	¾ of an oz.	Two hours.	Tried but once.
Lettuce	1 oz.	One hour.	

The ordinary house is not tight enough to prevent the gradual escape of the gas, so that even if the doors and ventilators are kept closed it gradually finds its way out through cracks and joints between the glass panes, and the strength is slowly lost. A long exposure to a moderate amount of the gas is less likely to cause injury to most plants, and at the same time is more effective against insects than a shorter exposure to a heavy charge.

All fumigation with cyanide should be done at night. Just why the plants are less likely to be injured at this time than during the day time is not plain, but it is nevertheless a fact. Apparently, the plants, when distended and turgid, are more resistant to the action of the gas than when slightly wilted, or it is possible that the higher temperature in the house in day time is responsible for the greater injury at that time. Whatever the cause, there can be no doubt that plants are less liable to injury from cyanide when treated after dark than when treated in daylight.

The cyanide treatment is, as has already been intimated, available for use against practically all the animal pests of greenhouses, but it is especially valuable for use against the white fly, mealy bug, thrips, and the various species of aphids. In houses containing a number of different kinds of plants the writer would recommend the use of, not to exceed three-quarters of an ounce, of cyanide per each one thousand cubic feet of air space. This charge may safely be used with all plants in the above list, and will at the same time be sure to kill all thrips, aphids and white fly, if left in the closed house over night. So light a charge, however, will probably not destroy all the mealy bugs, and it will have no effect on red spider, which seems to be particularly resistant to the gas. Neither will it destroy the eggs of any of the pests. Against scale insects it is useless, as the scale covering protects the insects from any strength of cyanide, which will not be fatal to growing plants. White fly, thrips, mealy bugs, and the aphis of the violet cannot be destroyed by smoking with tobacco, and are exceedingly hard to control by syringing, spraying or dipping. It is against these pests, therefore, that cyanide fumigation is especially valuable. Two tomato houses near Baltimore were fumigated several times for the white fly, which was very abundant, with the result that the fly was almost completely cleaned out for the time being, and the plants entirely uninjured. Another house at Annapolis, however, was treated to the same dose during the day time, and the plants very badly injured. The injury may have been partly attributable, in this instance, to the fact that the tomato plants were wet from a recent watering, but it is more likely that the greater part of the injury was due to the action of the sunlight and cyanide.

Coleuses badly infested with mealy bugs were several times treated at the above strength without injury to the plants, but not all the insects were killed, and it required several repetitions of the treatment to kill them all. The eggs were not affected. Experiments showed that the coleuses will stand a considerably stronger charge than three-quarters of an ounce to the thousand cubic feet, however, and it is the opinion of the writer that it will be found possible to control this pest, as well as the others named, with the cyanide treatment.

Roses and chrysanthemums were repeatedly treated for their respective plant-lice, with excellent results in every case. The gas proved more efficient and cheaper than the tobacco fumigation for the control of these pests.

A carnation house that was badly infested with the red spider, and which was treated with the recommended charge of three-quarters of an ounce per thousand cubic feet, did not show the hoped-for success, however, as the mites were apparently unaffected. Later attempts to increase the charge were made, and it was found that while the plants will withstand a slightly increased charge, the spiders are the more resistant, and it is impossible to kill them, on carnations, at least, without serious injury to the plants.

The process of fumigating with cyanide is quite simple, and not

Plate 8—Tomato house fumigated with hydrocyanic acid gas in daytime, showing injury to tops of plants.

at all dangerous, provided the proper precautions are taken. The first requirement is a knowledge of the exact cubic contents of the house to be treated. This should be known accurately, as upon it may depend the success or failure of the treatment. Having obtained the cubic contents of the house, the next step is to carefully weigh out the cyanide, three-quarters of an ounce for each thousand feet of space. If the space to be fumigated is a large one the cyanide should be divided into several equal packages, about three packages for each one hundred feet length of the house. Next, four times as many liquid ounces of water as there are ounces of cyanide are measured out and poured into earthen jars. These jars should be evenly distributed through the length of the house, about three for each one hundred feet of length, and the water distributed equally among them. The jars being placed, and the water in them, one-half as much commercial sulphuric acid as the jar contains water is poured in. Now, making sure that all ventilators are closed, and the house as tight as it can be made, the operator should proceed to the jar farthest from the door, and drop into it one of the bags of cyanide, then walk quickly to the next one, and so on, until the last bag is dropped into the jar nearest the door, when the door should be tightly closed and locked, so that no one can possibly get into the house. The whole operation should not require over ten or fifteen minutes. If an all-night exposure is to be given, it should be set off about 8 or 9 o'clock in the evening, and the house opened and aired before the sun becomes hot in the morning.

In dealing with the violet aphis it is necessary to use a much heavier charge than three-quarters of an ounce to the thousand cubic feet. Luckily the violet is capable of withstanding five or six times as much of the gas as many other plants, so that it is possible to treat it with a charge that is fatal to the aphids. In the foregoing table it will be seen that violets were uninjured by four ounces of cyanide per thousand cubic feet, and a charge of from four to five ounces should be used for the best results in dealing with this insect. The exposure should not be for less than an hour, and in my experiments a two-hour exposure resulted in no injury to the plants. A few of the lice escaped, even with this strong a charge, but the action of the gas was much more satisfactory than was that of the tobacco fumes when used against this pest.

In conclusion, it may be well to repeat the formula for generating the gas. The cyanide and sulphuric acid are obtainable at most large chemical supply houses, and sometimes at drug stores, though the drug-store article is likely to be expensive. It should be borne in mind that commercial sulphuric acid, and not the chemically pure article, is what is wanted. The potassium cyanide should be 98 per cent. pure. The following are the proportions in which the chemicals should be used to obtain the best results:

Potassium cyanide, one ounce.

Water, four liquid ounces.

Commercial sulphuric acid, two liquid ounces.

These proportions should not be varied to any considerable extent.

DUSTING.

The dusting of plants with insecticides is an old practice, but has, to a great extent, been replaced by spraying and fumigation. It is still practiced to some extent, however, in a number of houses. Dusting with Paris Green, Helebore, Pyrethrum powder, or other stomach poison, is a satisfactory treatment for most all of the leaf-eating insects, such as slugs, caterpillars, etc. The poison is best mixed with flour or air-slacked lime, and applied with a dust blower, or, if this instrument is not available, it may be put in a cloth bag and dusted over the plants by hitting the bag with a stick. Not many biting insects are found infesting greenhouses, and it is usually easier to remove such as do stray into the houses by hand than to go to the trouble of dusting with a poison.

Dusting plants with sulfur, as is generally practiced for controlling mildew, acts as a deterrent at the same time for plant-lice and other pests, but is not profitable as a means to combat insects alone.

Tobacco dust is also partially effective against certain pests that infest foliage, but is principally valuable as a remedy for root-infesting forms. Finely ground tobacco leaves or stems, or the sweepings from large tobacco storage houses, if mixed with the soil about the roots of plants, will discourage injury by wireworms, earthworms, and other pests that infest the roots. The tobacco acts not only as a preventive to the work of the worms, but will serve as a good fertilizer as well to many plants.

Lime, kainit, or other salty fertilizers sprinkled over the surface, or mixed with the soil of the benches, will also tend to restrict injury from these root-eating forms.

SPRAYING AND DIPPING.

The application of insecticides in liquid form, either by spraying upon the plants, or by dipping the plants in the solution, is one of the most effectual ways of controlling pests of the greenhouse. Both stomach poisons and contact insecticides may be applied in this way. The greater part of the injury to greenhouse-grown plants is due to sucking rather than biting insects, so that there is comparatively little use for stomach poisons in any form. About the only leaf-eating insects likely to be found upon indoor plants are stray caterpillars, and these may be easily removed by hand. The slugs (or snails, as they are erroneously called) are not so easily caught as the caterpillars, however, as they feed only at night. Spraying plants with water in which is a small amount of Paris Green, about a teaspoonful to two gallons of water, will help to get rid of them.

It is in the handling of the sucking insect pests, therefore, that spraying and dipping are chiefly employed. For this class of pests

some form of contact insecticide must be used, and these generally take the form of a soap solution, or an oil made to emulsify with water. Tobacco water, or tea, as it is sometimes called (being obtained by steeping tobacco leaves in hot water) is the best remedy yet found for thrips, if we except the cyanide fumigation. A pound of tobacco is steeped for half an hour in a gallon of water, and the plants sprayed with the solution. Thrips, owing to their feeding habits, are extremely hard to reach with a contact insecticide, but the presence of the tobacco water acts as a repellant, and largely prevents injury to the buds. The tobacco water is also useful for destroying the plant-lice of the rose and chrysanthemum and the mealy bug. Several tobacco extrtucts are manufactured by various firms, and are applicable to the same conditions. They are rarely ever effective at the strengths recommended by their manufacturers, however, and are not only more expensive, but are little, if any, more effective than the home-made extract.

In the experiments with different emulsified oils two proprietary remedies, viz., Fir-tree Oil and Lemon Oil, were used, as well as several different strengths of kerosene emulsion. The latter proved unsatisfactory for the most part, as it was extremely difficult to avoid injuring the tender foliage of the plants with it. Fir-tree Oil and Lemon Oil, both of which are quite expensive, are simply oil rendered miscible with water. The manufacturers recommend their use at one part of oil to 40 to 60 parts of water. At this dilution neither oil is sufficiently effective to pay for its use, but the proportion of oil may be greatly increased without danger of injury to the plants. When used one part of oil to fifteen or twenty parts of water they are both decidedly effective remedies for the rose aphis, chrysanthemum aphis, and the various other kinds of plant-lice, provided the application is carefully made. The oils mix readily with water in any proportion, and are perfectly safe to apply to any kind of foliage at the above-mentioned strength of one part oil to fifteen or twenty parts water.

A remedy, cheaper and as safe and effective as these oils, however, for the class of insects against which the oils are available, can be made by dissolving three or four ounces of any good laundry soap in a gallon of water. A good quality of soap should be used, as one containing a large proportion of impurities might result in injury. The soap, to be dissolved quickly, should be sliced into boiling water, and it must be completely dissolved, as small chunks of soap will otherwise be left upon the leaves, and may injure them. Of all the different materials used by the writer for spraying and dipping plants this simple soap solution proved the most desirable in many ways. It was equally as effective as the oils and tobacco extracts, and gave no signs of injury to the plants. It is easily prepared, and does not leave an objectionable coating upon the leaves, as do the tobacco extracts. Further than this, it is much cheaper than any of the patent insecticides.

Whale-oil soap seems to be about the only treatment available for the scale insects that infest greenhouse plants, aside from that of wash-

ing them off with a strong pressure of water, as already mentioned. It may be sprayed upon most of the plants liable to infestation with little or no danger of injury. Crotons, cycads and palms are most liable to become infested with scale insects, and all may be safely treated with this soap, using one pound of the soap to a gallon of water. Ferns, which are especially likely to be attacked by the hemispherical scale, cannot be sprayed with whale-oil soap, but should be treated with either Lemon Oil or Fir-tree Oil, either of which are fairly effective.

The writer's experience with spraying and dipping plants leads him to believe that where dipping is possible it is much to be preferred. Even with very careful work it is next to impossible to wet every part of a plant by spraying, and at the same time a great deal of the mixture is necessarily wasted in the process. Of course, plants that are planted in benches cannot be dipped, but those in pots can be dipped with far better results than will be obtained from spraying. If completely immersed in the mixture, the whole plant will be wet, and all insects upon it come in contact with the insecticide. A lot of potted chrysanthemums were completely freed of the black aphids by one thorough dipping in the Lemon Oil emulsion, using much less of the oil than would have been necessary for one thorough spraying, whereas a half dozen careful sprayings failed to completely eradicate the pests upon a similar lot of plants.

To dip plants successfuly and expeditiously, a deep vessel (something on the order of a milk can, with open top), that will allow complete immersion, with as little bending of the plant as possible, should be provided. A deep bucket will do, if the plants are not too tall. Whatever the vessel used, it should not have too great a diameter, as the greater the diameter of the receptacle the more of the spray mixture necessary to cover the plants. The plant is plunged top first in the mixture, the operator holding it by the pot, and after being allowed to remain immersed for a few seconds, or long enough to become thoroughly wet, it may be returned to its place on the bench. This process is somewhat slower than spraying, but the added effectiveness, coupled with the great saving in the amount of the spraying material used, will more than balance the extra labor.

In conclusion, the author wishes to acknowledge the co-operation of Mr. George Morrison, superintendent of the Mrs. Barton-Jacobs estate, Baltimore, and Mr. Ernest Ehle, superintendent of the greenhouses at the United States Naval Academy, Annapolis, who so kindly permitted the use of their houses in which to carry on some of the experiments; also Mr. Thomas White, of the Maryland Experiment Station, and Mr. C. A. Reed, of the Maryland Agricultural College, for assistance, and the Bureau of Entomology, United States Department of Agriculture, for identification of specimens.

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SWEET CORN INVESTIGATIONS.

By M. N. Straughn.*

INTRODUCTION.

The work reported upon in this bulletin was begun at the suggestion of Director Patterson in order to make a supplementary study to the matter presented in Bulletin No. 96 of this station, and also to get some preliminary data for use in taking up the systematic breeding of sweet corn. The breeding of sweet corn for seed is very important for Maryland, owing to her large interest in canning this product and also in supplying the city trade with green ear corn.

Maryland's interest in sweet corn can be better appreciated when it is realized that she stands fourth among the States in the production of canned corn and packs annually about one million cases,† or about one-eighth of all that is packed in the United States. For a small State to maintain this position it is quite necessary that improvements be made in the yields per acre and that constant attention be given to every point that may have a tendency to better the quality.

Most of the sweet corn that is planted in Maryland is grown in the New England States and in Northern Ohio. The reason for farmers purchasing seed from the North is due to the prevailing opinion that Northern grown seed will give a sweeter product than the home grown.

From the habits of the plant this idea and practice did not seem entirely rational, and it appeared that for good yields seed should be acclimated and that quality could be improved by breeding. Many farmers hesitate to grow sweet corn, owing to the difficulty in getting good stands and some years owing to the high price of seed. Inquiry has shown that these difficulties are attributed to early frosts in the sections growing sweet corn seed, cutting down the quantity of seed available and injuring the germinating power of that which is placed on the market.

†Two dozen cans to a case.
*Resigned March 1st, 1907, to take charge of Sweet Corn Investigations with the United States Department of Agriculture.

The results set forth by Dr. Stabler in Bulletin No. 96 demonstrate beyond a doubt the possibility of growing sweet corn seed in Maryland and showed the manner in which profits could be increased by the home production of seed. Several Maryland canners have grown their own seed for years, and thus secured strains or varieties which were specially adapted to their requirements and thus enabled them to establish enviable reputations for their pack of corn.

EXPERIMENTS CONDUCTED.

The work reported upon in this bulletin may be classified under the following heads:

1. Methods of Determining Sugar in Sweet Corn.

2. The Results of the Analysis of Different Varieties of Sweet Corn.

3. A Study of the Composition of Sweet Corn for the Purpose of Establishing a Method for Breeding.
   (a) The Relation of the Composition of Corn in the Matured (dried) and Green or Edible State.
   (b) The Relations of the Composition to Physical Characteristics.

4. The Breeding of Sweet Corn; Results of Work to Date.
   (a) Effects of the Ear to the Row Method of Breeding Sweet Corn.
   (b) Upper vs. Lower Ear for Sugar Content.
   (c) General Points to Be Observed in Selecting Seed Corn.

5. A Study of the Changes in Corn From Field to Table.

6. Observations on the Proportion of Husk, Grain and Cob.

7. Composition of Corn Grown in Different Latitudes.

8. The Composition of Sweet Corn.
   (a) Dried Corn.
   (b) Green Corn (ready for table use).
   (c) Canned Corn.

9. A Study of the Enzymes in Green and Dried Corn.

10. Relation of Variety to Insect Ravages.

METHODS OF ANALYSES.

The methods of analyses were those followed by the Association of Official Agricultural Chemists, except in the determination of sugars. The usual methods of determining sugars was not found to be adapted to sweet corn, and in order to overcome the difficulties encountered the following method was devised.

METHOD USED FOR THE DETERMINATION OF THE SUGARS.

The method used and found practical was as follows:

Weigh four grams of the sample into a one hundred cubic centimeter flask. Add fifty cubic centimeters of boiling 40 per cent. alcohol. Boil on the steam bath for two hours. Make nearly to volume with 95 per cent. alcohol. Cool to room temperature. Make to one hundred cubic centimeters volume. Shake and allow to stand until clear. Draw off fifty cubic centimeters. Add fifty cubic centimeters of water. Drive off the alcohol. Wash into a one hundred cubic centimeter flask. Add two to five cubic centimeters of sub-acetate of lead and two to five cubic centimeters of alumina cream. Throw out the lead with sodium carbonate. When cool make to volume; shake and filter. Take twenty-five cubic centimeters of the filtrate with five cubic centimeters of water; add fifty cubic centimeters of Sohxlet's modification of Fehling solution; bring to boiling; boil two minutes; add one hundred cubic centimeters of recently boiled distilled water. Filter immediately through a tarred Gooch (porcelain) crucible; wash with boiling water; and finally with a little strong alcohol and some ether. Dry at 100°C. for one-half hour; cool in dessicator and weigh as Cu2O. From this, the corresponding weight of invert sugar may be obtained. Fifty cubic centimeters of the remaining filtrate is inverted according to the method of Clerget, and the sugars are determined as above.

COMPOSITION OF DIFFERENT VARIETIES OF SWEET CORN GROWN IN DIFFERENT PARTS OF THE UNITED STATES.

In order to get some idea of the compositin of different varieties of sweet corn and of the same variety grown in different sections all the samples that could be procured were analyzed. Unfortunately, the source of the seed of many of the samples could not be learned, and it was impossible at the time of starting the work to obtain the same variety grown at many different places or at a sufficient range of latitudes and altitudes to give all of the data desired. There were forty-one samples of seed procured. These represented twenty-nine varieties, and were grown in at least seven different States. The results of the analysis are set forth in table one.

An examination of these results show that there is a considerable range in the sugar content of the different varieties. The sugar content, as manifested by these results, do not show in favor of any particular latitude. The early varieties seem, as a rule, to have less sugar than the later varieties, and Stowell's Evergreen, the variety which is recognized as the standard and most used for main crop and canning in this State, averages the sweetest, regardless of the place where grown.

In view of these results, it would seem that it was possible to grow as sweet a corn in this State as in the Northern States, and, again, these results would seem to indicate that by careful selection and breeding it would be possible to grow better and sweeter corn than the average and that it was a profitable line of research to pursue.

TABLE I.

Showing the composition of different varieties of Sweet Corn grown in different parts of the United States.

No.	NAME	Where Grown	Moisture	Ash	Protein	Fat	Crude Fibre	Reducing Sugars	Cane Sugar	Total Sugar	Pentosans	Starch
1	Earliest Sheffield	Ohio	10.07	1.63	11.85	8.15	1.97	1.68	2 23	3.91	6.63	55.79
7	Early Fordhook	"	9.50	1.90	12.29	8.49	1.75	0 62	2.00	2.62	6.59	54.86
30	Early Minnesota	......	9.60	1.87	10.71	8 56	1.79	1.22	1.59	2.81	7.05	57 61
31	Early Champion	......	9.41	1.86	11.41	7.97	2.19	1.80	1.97	3.77	6.89	56.50
32	Early Mammoth	.....	9.41	1.77	11 67	8.31	2.10	0.90	2.27	3 17	7 23	56.34
8	First of All	Ohio	9.53	1.72	11.93	7.88	2.13	0 88	3 43	4 31	6 84	55.66
10	Perry's Hybrid	"	9.77	1.73	11.58	8.31	1.97	0.41	2.93	3 34	6.65	56.65
15	Truckers Early	......	9.33	1.57	10.79	7.55	2.19	1.18	2.37	3.55	6.35	58 67
23	Cory's Extra Early	......	9.54	1 80	12.72	8.42	2.12	1.33	3.30	4.63	6.50	54 27
34	Crosby's Early	......	9 60	1.90	11 23	7.82	1.94	0.56	3.59	4.15	6.27	57 09
38	Stabler's Early	Md.	8.99	1.70	10.88	8.11	2.00	0.79	2.39	3.18	6.35	58.59
12	Cory's White Cob	Ohio	9.99	1.79	12.20	7.50	2.19	0.83	2 76	3.61	7.04	55 68
37	Squantonn	......	8 56	1.79	10.97	8.68	1 80	0.51	2.94	3.60	6.39	58.21
39	Black Mexican	......	9 55	1.80	12.02	7 86	1.82	0.42	3.44	3 86	6 45	56 64
41	Peep O'Day	Minn.	10 01	1.84	10.79	7.86	2.00	1.28	2.02	3.30	6.70	57 50
3	Golden Bantam	Conn.	9 99	1 82	11.50	7.86	2 00	0 21	4.95	5.16	5.96	55.69
5	Cosmopolitan	Ohio	9 71	1.71	11.67	7 64	1 86	1 36	1.73	3 09	6 51	57.81
9	Henderson's Metropolitan	"	8.76	1.85	12 20	8 38	2.01	0.58	2.15	2.73	6 36	57.71
36	Kendall's Early Giant	......	9 54	1.84	11.02	7.92	2 00	1.10	2.99	4.09	7.10	56.49
25 L	Salzer's Imp. Evergreen	Minn.	9.49	2.07	11.58	7.89	2.47	0.37	2.76	3.27	7.36	55.87
28	Evergreen Sweet	Neb.	9.70	1.74	11.23	8.31	2.23	1 82	2.66	4.48	7.30	55.01
13	Ne Plus Ultra	......	9.78	1.73	10.88	5.20	2.61	1.17	2.86	4.03	7.75	58.02
14	Hichox	......	9.74	1.72	11.50	7.44	2.21	1.36	2.81	4.17	6.19	57.03
					11.67	7.43						
16	Egyptian Corn	......	9.43	1.46	11.58	....	2.15	0.94	2.78	3.82	7.78	56.40
33	Late Mammoth	......	9.69	1.72	10.62	8.13	2.23	0.59	3.99	4.58	7.34	55.69
4	Winter Evergreen	Ohio	9.86	1.84	11.06	7.61	2.48	1.40	2.91	4.31	7.44	55.40
2	Stabler's Pedigree	Md.	10.04	1.71	10.97	8.30	2.33	1.90	4.02	5.92	7.36	53.37

TABLE I.—CONTINUED.

No.	NAME	Where Grown	Moisture	Ash	Protein	Fat	Crude Fibre	Reducing Sugars	Cane Sugar	Total Sugar	Pentosans	Starch
8	Country Gentleman	Ohio	9.67	1.65	11.23	7.27	2.18	0.77	3.09	3.86	7.41	56.72
				1.67								
18	" "	Ohio	9.72	1.75	10.44	7.26	2.31	1.15	3.24	4.49	7.26	56.77
19	" "	Conn.	9.19	1.84	11.06	6.82	2.58	1.12	1.66	2.78	7.40	58.33
21	" "	Ohio	8.77	1.71	10.79	7.16	2.42	1.17	3.82	4.49	7.77	56.39
24	" "	Colo.	8.22	1.72	12.29	6.95	2.59	1.66	2.24	3.90	6.74	57.59
26	" "	Minn.	9.49	1.79	11.23	7.89	2.21	1.28	2.24	3.52	6.52	57.35
27	" "	Ohio	10.02	1.82	11.50	7.87	2.62	1.29	2.43	3.72	7.14	55.31
40	" "	......	8.95	1.68	12.02	6.62	2.70	1.09	3.79	4.88	7.50	55.65
11	Stowell's Evergreen	Ohio	9.75	1.82	11.76	8.01	2.44	1.38	3.91	5.29	7.95	52.97
17	" "	......	9.70	1.80	11.93	8.16	2.48	1.37	3.85	5.22	7.88	52.83
20	" "	Conn.	9.27	1.90	11.50	7.55	2.66	1.66	3.90	5.56	7.49	54.07
22	" "	Ohio	8.74	1.72	11.76	7.95	2.58	1.26	3.21	3.47	7.54	56.24
29	" "	Iowa	9.03	1.87	11.50	7.97	2.34	2.05	2.97	5.02	6.94	55.33
35	" "	......	8.62	1.73	10.00	7.22	2.50	1.68	4.59	6.27	7.46	56.20

TABLE II.

Range and Average of Results in Table I. Calculated to Water, free basis.

	Ash	Protein	Fat	Crude Fibre	Sugars			Pentosan	Starch
					Reducing	Cane	Total		
Maximum	2.17	14.06	9.49	2.96	2.23	5.49	7.72	8.71	54.89
Minimum	1.61	10.93	5.65	1.91	1.23	1.76	2.99	6.78	70.13
Average	1.94	12.52	8.47	2.35	2.35	3.11	5.46	7.64	61.62

RELATION BETWEEN THE PERCENTAGES OF SUGAR IN THE MATURED, DRIED CORN (SEED) AND GREEN CORN (EDIBLE CONDITION).

One of the questions which arose was, is there any relation between the percentage of sugars in the green and dried corn? Some preliminary work in 1905 showed that a few rows of kernels could be removed from an ear of corn and the remainder would mature properly. By analyzing this green corn and then the dried corn a comparison of the percentage of sugars in the two stages of development could be made and establish whether any relation exists between the two. Three lots of corn were used for this. Lot 205 being Crosby's variety, 206 and 208 the Stowell's Evergreen variety. The results are in tables 3, 4 and 5.

TABLE III.

Showing the Relation of the Sugar Content in the Mature and Edible Sweet Corn—Crosby's Variety.

BREEDING LOT. NO. 205.

Serial Number.	Dried Seed. Total Sugars. %	Green Corn—Edible Condition. Moisture. %	Total Sugars. As Sampled. %	Calc. to Water free basis. %
205-5-1	4.62	68.65	5.16	16.46
205-5-2	4.50	66.50	4.37	13.04
205-3-5	4.20	64.56	5.59	15.57
205-3-3	4.12	63.54	5.24	14.37
205-2-1	4.04	68.88	4.51	14.49
205-3-2	3.84	65.86	4.18	12.24
205-4-4	3.74	71.64	5.43	19.15
205-6-3	3.70	68.66	5.12	16.35
205-2-3	3.60	61.90	4.65	12.21
205-7-2	3.58	71.18	4.76	16.53
205-3-1	3.42	69.35	3.82	12.46
205-4-2	3.38	62.82	5.03	13.53
205-4-1	3.30	70.57	3.57	12.13
205-4-5	3.02	66.74	5.37	16.18
205-12-2	2.82	71.82	5.83	20.69
Average.....	3.72	67.51	4.84	15.03

TABLE IV.

Showing the Relation of the Sugar Content in Mature and Edible Sweet Corn—Stowell's Evergreen Variety.

BREEDING LOT NO. 208.

Serial Number.	Dried Seed. Total Sugars. %	Green Corn—Edible Condition. Moisture. %	Total Sugars. As Sampled. %	Calc. to Water Free Basis. %
208-3-4	7.56	73.92	3.87	14.84
208-5-3	7.10	70.68	3.98	13.58
208-7-3	6.58	75.10	3.84	15.42
208-5-1	6.46	72.56	3.43	12.50
208-7-5	6.00	71.90	3.46	12.31
208-8-1	5.98	69.79	3.20	10.59
208-6-5	5.90	70.87	3.02	10.37
208-5-2	5.60	70.11	4.31	14.42
208-4-3	5.54	71.48	2.88	10.10
208-3-1	5.48	73.27	4.42	16.54
208-3-5	5.44	72.96	5.69	21.04
208-6-2	5.16	71.87	3.36	11.94
208-1-5	5.02	74.75	3.89	15.41
208-4-2	4.98	75.30	2.95	11.94
208-1-4	4.98	71.43	2.89	10.12
208-7-4	4.96	75.25	3.53	14.26
208-8-3	4.94	72.58	2.67	9.74
208-3-2	4.94	70.26	4.07	13.69
208-1-3	4.86	73.13	3.39	12.62
208-4-1	4.84	72.78	3.43	12.60
208-4-4	4.75	73.69	2.65	10.07
208-8-4	4.54	71.12	3.61	12.50
208-9-5	4.46	73.13	3.20	11.91
208-1-2	4.42	73.34	3.73	13.99
208-8-5	4.30	70.04	2.45	8.18
208-10-3	4.12	73.62	2.81	10.65
208-3-3	4.12	71.13	3.80	13.16
208-10-2	4.08	71.82	3.07	10.90
208-2-1	4.02	81.38	3.69	19.82
208-9-3	3.98	71.56	3.32	11.67
208-2-2	3.90	76.36	4.16	17.60
208-6-4	3.90	70.48	3.14	10.64
208-4-5	3.78	73.18	3.11	11.60
208-9-2	3.74	71.34	3.38	11.79
208-9-1	3.68	72.88	3.20	11.80
Average.....	4.97	72.43	3.47	12.87

TABLE V.

Showing the Relation of the Sugar Content in Mature and Edible Sweet Corn—Stowell's Evergreen Variety.

BREEDING LOT NO. 206.

Serial Number.	Dried Seed. Total Sugars. %	Green Corn—Edible Condition. Moisture. %	Total Sugars. As Sampled. %	Calc. to Water Free Basis. %
206-16-2	5.44	73.65	4.25	16.13
206-14-3	5.22	68.24	4.05	12.75
206-12-4	5.08	74.16	3.43	13.27
206-16-3	5.04	73.00	3.57	13.22
206-4-5	4.82	75.20	4.56	18.39
206-10-1	4.76	70.17	4.22	14.15
206-17-2	4.70	66.12	3.75	11.07
206-9-3	4.66	75.23	3.50	14.13
206-6-3	4.64	69.45	3.46	11.33
206-1-3	4.50	67.95	3.61	11.56
206-1-2	4.48	71.65	4.02	14.18
206-10-2	4.46	71.82	4.04	14.34
206-1-5	4.44	75.98	5.24	21.82
206-12-5	4.44	72.94	3.52	13.01
206-10-4	4.40	69.22	4.51	14.65
206-20-3	4.36	74.52	2.54	9.97
206-16-4	4.36	71.40	4.53	15.84
206-17-5	4.32	69.62	3.65	12.01
296-8-1	4.28	78.99	4.07	19.38
206-11-3	4.24	78.28	4.45	20.51
206-13-1	4.20	69.01	3.28	10.59
206-11-4	4.18	75.68	3.21	21.44
206-12-2	4.12	69.74	3.38	11.17
206-20-4	4.12	68.50	3.06	9.71
206-2-4	4.10	79.63	3.55	17.43
206-16-1	4.06	72.64	4.74	17.32
206-14-1	4.04	71.86	3.30	11.73
206-6-1	4.04	67.13	4.50	13.69
206-8-1	4.02	68.20	2.27	7.14
206-4-2	4.02	74.95	5.06	20.20
206-5-1	4.02	75.49	5.15	21.02
206-13-5	4.02	70.64	2.93	9.98
206-5-2	3.98	73.15	3.93	14.64
206-19-1	3.96	70.11	3.25	10.87
206-18-3	3.94	69.69	4.52	14.92
206-10-5	3.92	74.80	3.98	15.79
206-1-4	3.90	77.02	4.12	17.93
206-18-5	3.90	72.76	3.79	13.91
206-13-3	3.90	69.97	3.34	11.13
206-15-3	3.90	71.82	4.14	14.70
206-2-5	3.86	67.39	3.85	11.80
206-6-5	3.84	71.81	3.01	10.68
206-19-3	3.82	62.77	3.46	9.29
206-15-2	3.80	72.74	3.22	11.81
206-15-5	3.76	78.88	3.85	18.23

TABLE V—*Continued.*

Serial Number.	Dried Seed. Total Sugars %	Green Corn—Edible Condition. Moisture. %	Total Sugars. As Sampled. %	Calc. to Water Free Basis. %
206-16-5	3.76	66.44	3.60	10.73
206-7-1	3.66	72.32	3.83	13.84
206-6-2	3.64	65.82	3.90	11.41
206-2-5	3.62	67.39	3.85	11.80
206-18-2	3.54	70.20	3.54	11.88
206-9-5	3.54	75.98	4.57	19.03
206-8-2	3.54	77.44	2.67	11.83
206-18-4	3.48	79.48	4.15	20.24
206-7-3	3.42	68.59	3.38	10.76
206-19-4	3.40	73.01	2.64	9.78
206-19-2	3.22	69.90	3.51	11.66
206-4-4	3.20	71.50	3.65	12.81
206-7-5	3.20	76.22	2.65	11.13
206-6-3	3.00	69.45	3.46	11.33
206-8-4	2.88	72.96	3.38	12.50
206-13-4	2.66	69.84	6.55	21.72
206-8-3	2.44	75.06	2.62	10.50
Average.....	4.04	72.03	3.80	13.89

An examination of the above tables show no correllation between the sugars of the corn in the two stages mentioned; therefore, in breeding for high sugar content, it will be necessary to make the selection when the corn is in the green, edible or canning stage of ripeness.

AVAILABLE METHODS FOR BREEDING SWEET CORN. SELECTING SEED BY PHYSICAL APPEARANCE.

A careful canvass of the seedsmen developed the fact that they practice several ways of selecting corn that "is the sweetest;" and an examination was made of the ears selected by the two methods most commonly used.

First, ears were selected for their sweetness according to the color of the kernel. An ear whose kernels were of a deep amber color and more or less transparent is supposed to be much sweeter than one in which the kernels were opaque and were white.

Second, kernels having a fine wrinkle are supposed to be sweeter than those with a coarse wrinkle. Mr. W. W. Tracy, Sr., of the United States Department of Agriculture, kindly furnished the corn and assisted in picking our ears of the above types and physical characteristics, and analyses were made of them, which are tabulated below.

PHYSICAL APPEARANCE OF CORN AS AN INDEX TO SUGAR CONTENT.

TABLE VI.

The Relation of the Sugar Content of Corn to the Color of the Kernel.

Deep Amber Color. % of Sugar.	Whitish Color. % of Sugar.
6.14	5.28
5.34	4.58
4.34	4.48
4.32	4.48
4.28	4.44
4.20	4.38
4.00	4.34
3.92	4.32
3.42	3.86
....	3.58
Average...4.44	Average...4.37

The average percentage of sugars for each lot of corn are very near the same, indeed so nearly alike as to prevent any possibility of one's being able to select ears of corn of a high or low sugar content by this means.

WRINKLED APPEARANCE.

By means of the wrinkled appearance of the kernels two lots were selected with a fine wrinkle and two with a coarse wrinkle. A sample was taken from each of the individual ears and separate analyses made.

TABLE VII.

Showing the Relation of the Wrinkling of Corn to Its Sugar Content.

Ears Having Fine Wrinkled Kernels.	Ears Having Coarse Wrinkled Kernels.
Lot No. 1.	Lot No. 1.
5.28%	5.48%*
4.58%	4.28%
4.48%	4.00%
4.34%	3.92%
4.32%	3.42%
Average...4.60%	Average...3.90%

*Omitted from average.

Lot No. 2.	Lot No. 2
6.14%	4.44%
5.34%	4.38%
4.34%	4.26%
4.32%	3.86%
4.20%	3.58%
Average...4.87%	Average...4.10%

Here an apparent relation exist between the wrinkle of the kernel and the percentage of sugars.

The lowest percentage of sugar in the fine wrinkled kernels, is above the average percentage in the coarse wrinkled and the highest percentage of sugars in the individual ears having a coarse wrinkle is much less than the average in the fine wrinkled ones.

THE BREEDING OF SWEET CORN.

Sweet corn is grown in Maryland for two distinct purposes.

First, for canning.

Second, for the market garden trade.

FOR CANNING PURPOSES.

The varieties best suited to the canners' needs are Stowell's Evergreen and Country Gentleman, or Shoepeg. These two varieties seem to be more generally in demand, yet several men engaged very extensively in the packing industry have developed varieties suited to their needs—by years of selecting and growing their own seed.

The Stowell's Evergreen gives a larger yield per acre and packs more cases per ton than most varieties. It usually commands about two dollars less per ton in price than the Country Gentleman. The latter variety gives a more desirable canned product and brings more money per case.

VARIETIES USED IN SWEET CORN BREEDING EXPERIMENTS.

In starting the breeding work a quantity of each of the above varieties was purchased from Everett B. Clark, Milford, Conn., in the spring of 1905. Three plots of each variety were planted—two in Caroline county, two in Harford county and two at the Experiment Station. The ear to row method was used. A sample was taken from each ear and the sugars, protein and fat determined. At the end of the season the rows were harvested separately and an ear conforming to the type desired was selected from each row, and sugars, protein and fat determined in these samples.

By means of these results a comparison of the composition of the parent and progeny can be made, and the influence exerted upon the corn by growing it in Maryland can be noticed.

The results are given in the following Table VIII. The analysis of the parent ear and its progeny are placed one below the other alternately.

TABLE VIII.

Showing Composition of Sweet Corn, Caroline County Breeding Plot.

Grown by F. P. Roe, Greensboro, Md., 1905—Variety: Stowell's Evergreen.

Laboratory Number	Number of Row	Total Sugars	Protein	Fat
Progeny 640	1	7.86%	....	7.67
Parent 241	22	6.01%	9.83	7.75
Progeny 641	2	4.90%	10.44	7.76
Parent 245	26	5.24%	10.89	9.70
Progeny 642	3	4.94%	8.34	7.15
Parent 240	21	3.96%	9.30	7.40
Progeny 643	4	5.72%	7.99	7.60
Parent 232	13	5.64%	11.06	7.88
Progeny 644	5	4.90%	8.78	7.75
Parent 251	32	3.21%	10.79	8.34
Progeny 645	6	5.26%	8.16	8.07
Parent 240	21	3.95%	9.30	7.40
Progeny 646	7	5.14%	8.25	7.41
Parent 248	28	4.00%	10.44	8.76
Progeny 647	8	5.76%	8.16	7.23
Parent 240	21	3.95%	9.30	7.40
Progeny 648	9	4.84%	8.34	7.04
Parent 242	23	5.75%	10.09	7.87
Progeny 649	10	4.74%	8.86	7.63
Parent 230	11	5.57%	11.23	8.56
Progeny 650	11	4.96%	8.60	7.02
Parent 240	21	3.95%	9.30	7.40
Progeny 651	12	5.12%	9.04	6.62
Parent 244	25	4.06%	11.41	8.14
Progeny 652	13	4.86%	8.78	7.65
Parent 242	23	4.75%	10.09	7.87
Progeny 553	14	5.62%	9.13	6.98
Parent 238	19	4.45%	10.71	8.17
Progeny 654	15	4.90%	9.83	7.03
Parent 233	14	5.30%	9.92	7.58
Progeny 655	16	4.76%	8.95	8.02
Parent 231	12	5.28%	10.18	8.06
Progeny 656	17	4.14%	10.53	7.45
Parent 240	21	3.95%	9.30	7.40
Progeny 657	18	5.92%	6.32	7.45
Parent 223	4	5.30%	9.21	8.39
Progeny 658	19	4.82%	9.13	9.02
Parent ....240—	21	3.95%	9.30	7.40
Progeny 659	20	5.00%	9.04	7.45
Parent 244	25	4.00%	11.41	8.14

TABLE VIII—*Continued.*

Laboratory Number	Number of Row	Total Sugars	Protein	Fat
Progeny 660	21	4.60%	8.07	7.09
Parent 223	4	5.30%	9.21	8.39
Progeny 661	22	6.32%	5.35	7.30
Parent 244	23	4.05%	11.41	8.14
Progeny 662	23	6.08%	8.51	7.29
Parent 222	3	4.69%	11.50	8.97
Progeny 664	25	4.10%	11.50	8.97
Parent 226	7	5.50%	9.56	8.36
Progeny 665	26	4.52%	8.42	7.54
Parent 235	16	5.75%	9.56	8.20
Progeny 666	27	4.60%	10.27	8.05
Parent 230	11	5.57%	11.23	8.56
Progeny 667	28	4.62%	8.34	8.27
Parent 247	28	4.50%	10.09	7.88
Progeny 668	29	4.40%	7.46	8.04
Parent 245	26	5.24%	10.88	9.70
Progeny 669	30	4.08%		7.38
Parent 240	21	3.95%	9.30	7.40
Progeny 670	31	4 08%	9.30	8.12
Parent 227	8	4.54%	9.13	9.70
Progeny 671	32	5.16%	9.13	7.97
Parent 240	21	3.95%	9.30	7.40
Progeny 672	33	6.00%	9.74	8.71
Parent 244	25	4.06%	11.41	8.14
Progeny 673	34	5.08%	7.63	8.39
Parent 248	29	4.00%	10.44	8.76
Progeny .... .674	35	4.12%	12.02	7.65
Parent 251	32	3.21%	10.79	8.34
Progeny 675	36	6.22%	9.39	7.40
Parent 240	21	3.95%	9.30	7.40
Progeny 676	37	5.20%	9.83	7.45
Parent 230	11	5.57%	11.23	8.56
Progeny 677	38	4.80%	9.83	7.82
Parent 240	21	3.95%	9.30	7.40
Progeny 678	39	4.84%	7.81	7.87
Parent 243	24	4.16%	10.62	7.93
Progeny 679	40	4.34%	9.83	7.69
Parent 225	6	4.38%	11.58	8.83
Average of progeny		5 03%	8.88	7.67
Average of parent		4 57%	10 22	8 12

The figures which are marked "Progeny" correspond to the corn to be planted in 1906 and which was grown from the corn corresponding to the figures marked "Parent," the latter being planted in 1905.

An examination of the above table shows the sugar content in the progeny to be higher than it is in the parent. Attention is called to the fact that no attempt was made to secure the ears having the highest percentage of sugars from each row, simply one ear from each row being selected, and that, the one conforming more nearly to the type of corn desired. In the protein the reverse is true; in nearly every instance the parent has a higher per cent. than the progeny, and this is also true regarding the percentage of fat.

In the above work no attempt was made to select ears having a high sugar content, and yet in the greater number of cases the progeny has the higher percentage of sugar. In the next breeding plot, Table IX, two and three ears were selected from each row and a sample taken from each and the sugars determined. Out of eleven rows from which ears were selected for the 1906 breeding plot eight contained ears higher in sugar content than the parent ears, and from no row were more than three ears analyzed. Attention is called to the fact that the parent ears, whose sugar content was the highest, produced progenies with a higher percentage of sugar than any of the other ears and higher than the highest of their parent. Note ear No. 152, whose sugar content was 6.76 per cent. and whose progenies contained 6.98 per cent. and 7.52 per cent. These ears were selected one from the center of the row and one from near each end. It may be said these are the best rows which have been picked. Yes, and this is the idea of the ear to row plot: to pick out the best ears for perpetuation or breeding. This ear No. 152 also serves another purpose, in that it shows the ability of one ear over some others to transmit its qualities.

This ear, raised in Connecticut and having the highest percentage of sugar of any of the 150 ears purchased, and after planting in Maryland produced corn still higher in sugar, showed quite evidently a hereditary tendence rather than being an accident.

Attention is called to the manner in which the ears were selected—one from the center of the row and one from near each end. Then the fact of its being a real difference, and not the result of any advantage it had received in drainage, sunlight or plant food, but to heredity.

Following is a table showing the results of these analyses:

TABLE IX.

Showing the Relative Sugar Content in Parent and Progeny—Stowell's Evergreen Variety.

SWEET CORN BREEDING TESTS.

Parent Ear			Progeny	
Serial No.	Total Sugars %		Serial No.	Total Sugars %
142	5.30	....	842 843	6.02 6.22
143	5.20	....	844 845	4.10 4.12
150	5.88	....	856 857	6.30 5.42
151	6.44	....	858 859	6.78 6.24
152	6.76	....	860 861 862	6.98 5.04 7.52
153	6.00	....	863 864	4.26 5.76
154	4.96	....	865 866 867	5.56 5.36 4.34
155	4.62	....	868 869 870	3.92 4.38 3.82
162	5.02	....	888 889	5.28 6.32
172	4.12	....	910 911	4.74 4.84
177	5.18	....	916 917	5.34 5.40
Average ...	5.42	....	....	5.36

EFFECT OF EAR TO ROW METHOD OF BREEDING ON SUGAR CONTENT.

In the work of breeding by the ear to row method three plots were used and analysis of a number of ears from each row were made, and these ears allowed to ripen, and they were planted the season 1907. The results of the analysis are tabulated below, and under the row is given the analysis of each ear, an average for the row and, finally, the general average of the entire breeding lot.

TABLE X.

Stowell's Evergreen.

BREEDING LOT NO. 208.

ROW NO. 1.

(Parent ear, sugars in the dried corn, 7.52%.)

No. of Ear.	Moisture. %	Total Sugars.	
		As Sampled. %	Calc. to Water Free Basis. %
1	75.40	4.12	16.75
2	73.34	3.73	13.99
3	73.13	3.39	12.62
4	71.43	2.89	10.12
5	74.75	3.89	15.41
Average....	73.61	3.60	13.64

ROW NO. 2.

(Parent ear, sugars in the dried corn, 6.98%.)

1	81.38	3.69	19.82
2	76.36	4.16	17.60
3	77.86	2.84	12.83
4	77.37	4.21	18.60
5	75.69	3.06	12.59
Average....	77.73	3.59	16.12

ROW NO. 3.

(Parent ear, sugars in the dried corn, 6.78%.)

1	73.27	4.42	16.54
2	73.26	4.07	13.69
3	71.13	3.80	13.16
4	73.92	3.87	14.84
5	72.96	5.69	21.04
Average....	73.91	4.37	16.75

Row No. 4.

(Parent ear, sugars in the dried corn, 6.32%.)

No. of Ear.	Moisture. %	Total Sugars. As Sampled. %	Total Sugars. Calc. to Water Free Basis. %
1	72.78	3.43	12.60
..	75.30	2.95	11.94
..	71.48	2.88	10.10
..	73.69	2.65	10.07
..	73.18	3.11	11.60
Average....	73.29	3.00	11.23

Row No. 5.

(Parent ear, sugars in the dried corn, 6.30%.)

1	72.56	3.43	12.50
2	70.11	4.31	14.42
3	70.68	3.98	13.58
4	75.31	3.38	13.91
5	73.78	3.74	14.26
Average....	72.57	3.77	13.74

Row No. 6.

(Parent ear, sugars in the dried corn, 6.22%.)

1	71.60	2.75	9.68
2	71.87	3.36	11.94
3	72.10	3.20	11.47
4	70.48	3.14	10.64
5	70.87	3.02	10.37
Average....	71.38	3.09	10.80

Row No. 7.

(Parent ear, sugars in the dried corn, 6.04%.)

1	72.52	3.20	11.65
2	73.04	4.25	15.76
3	75.10	3.84	15.42
4	75.25	3.53	14.26
5	71.90	3.46	12.31
Average....	73.56	3.66	13.84

Row No. 8.

(Parent ear, sugars in the dried corn, 6.02%.)

1	69.79	3.20	10.59
2	72.02	3.16	11.29
3	72.58	2.67	9.74
4	71.12	3.61	12.50
5	70.04	2.45	8.18
Average....	71.11	3.02	10.45

Row No. 9.

(Parent ear, sugars in the dried corn, 5.76%.)

No. of Ear.	Moisture. %	Total Sugars. As Sampled. %	Total Sugars. Calc. to Water Free Basis. %
1	72.88	3.20	11.80
2	71.34	3.38	11.79
3	71.56	3.32	11.67
4	69.46	3.55	11.62
5	73.13	3.20	11.91
Average....	71.67	3.33	11.75

Row No. 10.

(Parent ear, sugars in the dried corn, 5.56%)

No. of Ear.	Moisture. %	Total Sugars. As Sampled. %	Total Sugars. Calc. to Water Free Basis. %
1	76.12	2.33	9.76
2	71.82	3.07	10.90
3	73.62	2.81	10.65
4	73.04	3.20	11.87
Average....	73.65	2.85	10.82
Average of Entire Breeding Lot:			
	73.25	3.43	12.82

This is the second season this corn has been grown in Maryland, which may account for the apparent constancy in some of its individual ears transmitting a high percentage of sugars.

The parent ears of Breeding Lot No. 208—Stowell's Evergreen—were selected because of their high sugar content, every one of which contained over 5.56 per cent. of sugar, and even as high a percentage as 7.52 per cent. was found (these being determinèd in the matured dried corn ("seed"). Yet the average percentage of sugar found in the green corn of this breeding lot was less than the average for Lot No. 206, which did not contain an ear having over 5 per cent. of sugars. This is more evidence of the fact that no relation exists between the percentage of sugars in the green and dried corn.

The maximum percentage of sugars found in any ear of this lot is 21.04, the minimum 9.68, and 12.82 for the average.

A comparisòn of the rows reveals the fact that while the average percentage of sugars in rows 1, 2, 3, 5, 7 are above the average found in rows 6, 8, 9 and 10, and even the ears with the highest percentage of sugars in rows 6, 8, 9, 10 is not as great as the average for rows 1, 2, 3, 5, 7; and the ears having the lowest percentages of sugars in rows 2 and 3 have a greater percentage than the highest in rows 4, 6, 8, 9, 10. This is very important in breeding, for the parent ear must have transmitted this tendency to produce high percentages of sugars and,

furthermore, it would allow of selecting ears other than ones analyzed from these rows (2 and 3, whose ears have such a high sugar content) with some certainty of obtaining progenies with high amounts of sugars.

TABLE XI.

Stowell's Evergreen.

BREEDING LOT No. 206.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
		Row No. 1.	
1	66.36	3.20	9.51
2	71.65	4.02	14.18
3	67.95	3.61	11.56
4	77.02	4.12	17.93
5	75.98	5.24	21.98
Average....	71.79	4.04	14.32
		Row No. 2.	
1	79.90	4.46	22.19
2	74.02	2.19	8.43
3	73.26	2.65	9.91
4	79.63	3.55	17.43
5	67.39	3.85	11.80
Average....	74.84	3.34	13.27
		Row No. 3.	
1	74.58	3.45	13.57
2	70.82	4.03	12.81
3	71.26	4.79	16.68
4	74.01	3.83	14.74
Average....	72.67	4.02	14.71
		Row No. 4.	
1	66.75	4.78	14.30
2	74.95	5.06	20.20
3	72.48	5.19	18.87
4	71.50	3.65	12.81
5	75.20	4.56	18.39
Average....	72.14	4.65	16.69
		Row No. 5.	
1	75.49	5.15	21.02
2	73.15	3.93	14.64
3	77.58	3.43	15.31
4	73.32	3.31	12.59
5	73.68	3.73	14.18
Average....	74.64	3.92	15.46

Row No. 6.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	67.13	4.50	13.69
2	65.82	3.90	11.41
3	69.45	3.46	11.33
4	71.81	3.01	10.68
Average....	68.55	3.72	11.83
Row No. 7.			
1	72.32	3.83	13.84
2	72.28	3.34	12.99
3	68.59	3.38	10.76
4	69.30	4.37	14.23
5	76.22	2.65	11.13
Average....	72.14	3.15	12.60
Row No. 8.			
1	68.20	2.27	7.14
2	77.44	2.67	11.82
3	75.06	2.62	10.50
4	72.96	3.38	12.50
5	76.99	3.25	14.13
Average....	74.13	2.84	10.98
Row No. 9.			
1	70.98	2.64	9.10
2	71.71	4.75	16.79
3	75.23	3.50	14.13
4	73.88	4.12	15.77
5	75.98	4.57	19.03
Average....	73.55	3.92	14.82
Row. No. 10.			
1	70.17	4.22	14.15
2	71.82	4.04	14.34
3	69.99	3.75	12.50
4	69.22	4.51	14.65
5	74.80	3.98	15.79
Average....	71.20	4.10	14.24
Row No. 11.			
1	71.75	3.65	12.60
2	70.82	4.53	15.52
3	78.28	4.45	20.51
4	75.68	5.21	21.44
5	75.80	3.10	12.81
Average....	74.46	4.17	16.33
Row No. 12.			
2	69.74	3.38	11.17
3	74.85	3.61	14.35
4	74.16	3.43	13.27
5	72.94	3.52	13.01
Average....	72.92	3.48	12.85

Row No. 13.

No. of Ear.	Moisture: %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	69.02	3.28	10.59
2	65.00	2.83	8.09
3	69.97	3.34	11.13
4	69.84	6.55	21.72
5	70.64	2.93	9.98
Average....	68.89	3.78	12.15

Row. No. 14.

1	71.86	3.30	11.73
2	72.00	3.34	11.93
3	68.24	4.05	12.75
4	72.82	3.36	12.36
5	74.97	3.89	15.54
Average....	71.98	3.59	12.81

Row No. 15.

1	72.74	3.22	11.81
2	71.82	4.14	14.70
3	74.63	5.32	20.97
4	78.88	3.85	18.23
Average....	74.51	4.13	16.20

Row No. 16.

1	72.64	4.74	17.32
2	73.65	4.25	16.13
3	73.00	3.57	13.22
4	71.40	4.53	15.84
5	66.44	3.60	10.73
Average....	71.43	4.14	14.49

Row No. 17.

2	66.12	3.75	11.07
4	71.21	3.39	11.77
5	69.62	3.65	12.01
Average....	68.98	3.66	11.80

Row No. 18.

1	78.99	4.07	19.38
2	70.20	3.54	11.88
3	69.69	4.52	14.92
4	79.48	4.15	20.24
5	72.76	3.79	13.91
Average....	74.22	4.01	15.55

Row No. 19.

1	70.11	3.25	10.87
2	69.90	3.51	11.66
3	62.77	3.46	9.29
4	73.01	2.64	9.78
5	72.98	2.45	9.09
Average....	69.75	3.06	10.12

Row No. 20.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	73.89	3.59	13.75
2	76.02	4.42	18.43
3	74.52	2.54	9.97
4	68.50	3.06	9.71
Average....	73.23	3.40	12.70
Average of Entire Breeding Lot (No. 206):			
	72.30	3.77	13.61

The parent ears of this breeding lot were furnished by the Bureau of Plant Industry, United States Department of Agriculture, and had been grown in the western part of New York for several seasons. While the average of several rows shows a high percentage of sugars, some ears have fallen low in these rows and do not appear to be as constant in transmitting a high sugar content as Lot No. 208.

TABLE XII.

Crosby's Variety.

BREEDING LOT NO. 205.

Row No. 2.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	68.88	4.51	14.49
2	63.20	4.14	11.25
3	61.90	4.65	12.21
4	72.40	5.59	20.25
Average....	66.59	4.72	14.15
Row No. 3.			
1	69.35	3.82	12.46
2	65.86	4.18	12.24
3	63.54	5.24	14.37
4	70.01	4.21	14.06
5	64.56	5.59	15.57
Average....	66.67	4.61	13.83
Row No. 4.			
1	70.57	3.57	12.13
2	62.82	5.03	13.53
3	60.88	4.61	11.79
4	71.64	5.43	19.15
5	66.74	5.37	16.18
Average....	66.53	4.80	14.34

Row No. 5.

No. of Ear.	Moisture. %	Total Sugars. In Green Corn. %	Total Sugars. Calc. to Water Free Basis. %
1	68.65	5.16	16.46
2	66.50	4.37	13.04
Average....	66.57	4.76	14.23
		Row No. 6.	
1	81.35	6.05	32.44
2	68.66	5.12	16.35
3	76.50	6.41	27.28
Average....	75.50	5.86	23.92
		Row No. 7.	
1	66.60	4.20	12.58
2	71.18	4.76	16.53
Average....	68.89	4.48	14.40
		Row No. 8.	
1	77.38	5.64	24.96
2	74.09	5.80	22.48
3	70.57	5.69	19.35
Average....	74.01	5.71	21.97
		Row No. 9.	
1	77.06	5.90	25.77
2	82.80	4.46	25.93
Average....	79.93	5.18	25.81
		Row No. 12.	
1	71.82	5.83	20.69
2	66.50	6.08	18.15
Average....	69.16	5.95	19.42
		Average of Entire Breeding Lot (No. 205):	
	70.43	5.12	17.32

The Crosby's variety is much sweeter than the Stowell's. There is a great variation in the percentage of sugars in the individual ears, but no more than the Stowell's variety shows. The ears from rows No. 8 and 9 are very interesting and will be planted in a plot to themselves next season.

UPPER VS. LOWER EAR FOR SUGAR CONTENT.

During the season of 1906 it was thought desirable to make determinations of the percentage of sugars in the upper and lower ears from the same stalk to show whether any advantage would be derived

by selecting either the upper or lower ear for seed. Below is tabulated the results of seventeen such determinations, the ears from the same stalk being placed beside each other.

TABLE XIII.

Comparing the Sugar Content of the Upper and Lower Ears.

Upper Ear			Lower Ear		
Serial Number	Moisture %	Total Sugars Calc. to water free basis %	Serial Number	Moisture %	Total Sugars Calc. to water free basis %
206-2-3	73.26	9.91	206-2-2	74.02	8.43
206-3-5	74.01	14.74	206-3-4	71.26	16.68
206-4-4	71.50	12.81	206-4-3	72.48	18.87
206-5-4	73.32	12.59	206-5-3	77.58	15.31
206-6-2	65.82	11.41	206-6-1	67.13	13.69
206-7-2	74.28	12.99	206-7-1	72.32	13.84
206-7-4	69.30	14.23	206-7-3	68.59	10.76
206-8-1	68.20	7.14	206-8-1	77.44	11.83
206-8-4	72.96	12.50	206-8-3	75.06	10.50
206-9-4	73.88	15.77	206-9-3	75.23	14.13
206-10-2	71.82	14.34	206-10-1	70.17	14.15
206-10-4	69.22	14.65	206-10-3	69.99	12.50
206-11-2	70.82	15.52	206-11-1	71.75	12.60
206-11-4	75.68	21.44	206-11-5	75.80	12.81
205-12-5	72.94	13.01	206-12-4	74.16	13.27
206-13-3	69.97	11.13	206-13-2	65.00	8.09
206-14-1	71.86	11.73	206-14-2	72.00	11.93
Average	71.70	13.29	Average	72.35	12.90

Looking at the averages for the two, it will be noted that there is scarcely any difference in them, 13.29 per cent. being the average for the upper ear and 12.90 per cent. for the lower ear. No advantage would be gained in selecting the upper or the lower ear, provided they were of equal development, maturity and vitality. A point of interest in the above set of results is the close agreement of the moisture content of the two ears from the same stalk. Taking the first upper ear to show a low percentage of moisture (65.82 per cent.), it is found that the corresponding lower ear has also a low moisture content (67.13 per cent). This is found to hold true in the majority of cases. This would seem to indicate that the stalk controlled to a greater or less degree the amount of moisture taken up by the ears.

POINTS TO BE OBSERVED IN SELECTING SEED CORN.

In selecting seed corn attention must be given to the habits of the growth of the plant, in addition to the sugar content of the ear. See that the ear which is used for breeding has vitality and give a good stand of strong, vigorous stalks. Select seed from those stalks

that are either free from suckers or show little inclination to sucker. Usually it will be well to select seed from those stalks which give two good ears. Select ears that have white silk rather than pink or colored, as the white silked ears will usually have whiter kernels, which will look better in the can, and then the white silk, if any should escape the cleaner and get into the can, will not get dark in processing and show up as badly as the pink and colored silks.

Select typical ears of the variety or strains you are growing. Select ears with small cobs. Also select ears with white cobs, as the kernels from white cobs are whiter than from colored cobs. For suggestions as to harvesting and curing see Bulletin No. 96.

EFFECT OF STORAGE AT VARIOUS TEMPERATURES.

It is well known that sweet corn soon loses its sweet taste, becoming flat and insipid upon standing. A series of investigations were undertaken to show the change in percentage of sugars the corn undergoes and what effect storing in the refrigerator would have.

Three lots of corn were used, two of Stowell's Evergreen and one of Country Gentleman. About fifty ears, all in about the same state of ripeness, were pulled. The sugars determined in a number of ears at once and the remainder stored; one-half at room temperature and the remaining half in the refrigerator. One-third were stored in the husk; one-third were husked, and the remainder were husked and wrapped in oiled paper.

Ears were taken from each lot at the end of 24, 48, 72, 96, 112 and 120 hour periods, and the moisture and total sugars determined.

These results are tabulated below.

TABLE XIV.

	Moisture	Total Sugars
Stowell's Evergreen No. 1	78.03	4.59
Sample pulled and sugars determined at once	75.84	4.74

TABLE XV.

STOWELL'S EVERGREEN NO. 1.

Unhusked room temperature 25° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars: In green Corn, %	Total Sugars: Calc. to water free basis, %	Remarks
504	24	77.80	3.06		Good condition.
505	24	63.68	3.81		" "
518	48	75.77	2.31		Tasted flat.
519	48	71.26	1.85		" "
542	96	69.05	1.92		Kernels looked wrinkled. Tasted flat and sour.

TABLE XVI.

*Unhusked — Stored in Refrigerator.**

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars In green Corn, %	Total Sugars Calc. to water free basis, %	Remarks
510	24	77.94	2.80		Tasted flat.
511	24	79.63	3.22		" "
524	48	75.21	2.80		Wrinkled and taste flat
525	48	74.45	2.50		" " " "
548	96		2.38		Kernels very wrinkled and tasted flat.
549	96	76.61	2.17		" " " "

*Refrigerator showed a temperature of 23½° C. (74° F.) during first 24 hrs. after that 17° C. (63° F.)

TABLE XVII.

STOWELL'S EVERGREEN NO. 1.

Ears husked and stored at room temperature 26° C.

Serial Number	No. Hrs. Stored.	Moisture %	Total Sugars In green Corn, %	Total Sugars Calc. to water free basis, %	Remarks
506	24	75.75	1.81		Wrinkled and very dry.
507	24	67.26	1.59		" " " "
520	48	72.02	1.83	.	Very much wrinkled.
521	48	74.00	1.78		" " "
545	96	78.61	1.74		Tasted sour.

TABLE XVIII.

STOWELL'S EVERGREEN NO. 1.

Ears Husked and Stored in Refrigerator.

Serial Number	No. Hours Stored	Moisture %	Total Sugars In green Corn, %	Total Sugars Calc. to water free basis, %	Remarks
512	24	67.98	2.09		Tasted flat
513	24	76.05	2.59		" "
526	48		2.13		Tasted tough and flat and a little astringent
550	96	74.13	2.26		Tasted flat and sour—wrinkled

TABLE XIX.

STOWELL'S EVERGREEN NO. 1.

Ears husked, wrapped in oil paper, stored at room temperature 26° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars In green Corn, %	Total Sugars Calc. to water free basis, %	Remarks
508	24	74.79	2.25		Good condition
509	24	74.46	2.11		
522	48	73.44	1.89		Tasted flat
523	48	75.55	1.83		" "
546	96	73.07	1.78		
547	96	72.78	1.44		

TABLE XX.

STOWELL'S EVERGREEN NO. 1.

Ears husked, wrapped in oiled paper, stored in refrigerator.

Serial Number	No. Hours Stored	Moisture %	Total Sugars In green Corn, %	Total Sugars Calc. to water free basis, %	Remarks
514	24	75.66	2.15		In good condition.
515	24	71.36	4.09		Tasted sweeter than 514
528	48	74.83	1.99		Tasted flat.
529	48	75.16	1.69		" "
552	96	77.41	1.69		Appearance good, tasted sour.
553	96	72.84	1.98		

TABLE XXI.

COUNTRY GENTLEMAN NO. 2.*

Unhusked, stored at room temperature 28° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
530	24	75.81	2.17		Somewhat wrinkled, poor taste.
531	24	70.01	2.87		" " "
554	72	61.38	1.74		Wrinkled and tasted sour.
555	72	70.66	2.12		" " " "
578	96	65.85	1.85		Dry and wrinkled.
579	96	68.17	1.65		" " "
602	120	63.22	1.70		
603	120	67.79	1.60		

*—Samples pulled and Sugars determined at once gave................3.04%
................3.96%

TABLE XXII.

COUNTRY GENTLEMAN NO. 2.

Unhusked stored at refrigerator temperature 20° C.

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
536	24	68.43	2.63		Good appearance but tasted flat.
537	24	61.31	2.18		" " " "
560	72	66.15	2.86		
561	72	69.27	1.85		
584	96	65.92	1.49		Wrinkled and tasted sour.
608	120	67.53	1.95		Very wrinkled.
609	120		1.83		" "

TABLE XXIII.

Country Gentleman No. 2.

Ears husked and stored at room temperature 28° C.

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
532	24	64.33	2.04		Wrinkled and poor taste
533	24	66.28	1.46		" " " "
556	72	61.45	1.69		Very dry, wrinkled and sour.
557	72	64.02	1.31		" " " "

TABLE XXIV.

Country Gentleman No. 2.

Ears Husked and Stored in Refrigerator 20° C.

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
538	24	64.74	2.47		Tasted flat.
539	24	67.21	2.24		" "
562	72	64.23	2.33		Very wrinkled and dry.
563	72	64.58	1.99		" " " "
610	120	59.95	1.69		
611	120	66.77	1.71		

TABLE XXV.

Country Gentleman No. 2.

Ears Husked, wrapped in oiled paper; stored room temperature 28° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
534	24	63.37	1.64		Dry and wrinkled, tasted flat
535	24	66.41	2.23		" " " "
558	72	66.22	1.28		Dry, Sour taste.
559	72	63.05	1.97		
582	96	64.83	1.66		
583	96	70.80	1.72		

TABLE XXVI

Country Gentleman No. 2.

Ears husked wrapped in oiled paper; stored in refrigerator 20° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
540	24	66.65	2.31		
541	24	67.09	2.04		
564	72	69.42	1.63		
565	72	68.90	1.78		
588	96	65.68	1.58		
589	96	69.28	1.60		
612	120	64.21	1.48		Very dry and wrinkled.
613	120	68.33	1.25		

TABLE XXVII.

Stowell's Evergreen No. 3.*

Ears unhusked and stored at room temperature 27° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
566	24	76.77	1.73		Tasted flat, wrinkled.
567	24	76.14	2.19		
590	48	75.91	1.85		Wrinkled and Dry.
591	48	77.56	2.06		" " "
614	72	73.82	1.29		Sample wrinkled, dry and tough.
615	72	71.70	1.84		" " " "
626	96	70.60	1.39		Very wrinkled, tasted flat.
627	96	71.15	1.25		" " "

* Sugars in fresh corn was 4.00%

TABLE XXVIII.

Stowell's Evergreen No. 3.

Ears unhusked; stored in refrigerator at 20° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
572	24	78.33	1.77		Tasted sour.
573	24	75.40	1.75		" "
596	48	73.69	1.80		Wrinkled and dry at bottom of refrigerator.
597	48	74.62	2.08		" " " "
632	72	75.06	1.52		Samples dry, tasted flat.
633	72	74.31	1.85		" " " "

TABLE XXIX.

Stowell's Evergreen.

Ears unhusked and stored at room temperature 28° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars		Remarks
			In green Corn, %	Calc. to water free basis, %	
568	24	73.32	1.45		Dry and wrinkled, taste sour.
592	48	67.28	1.97		Dry and wrinkled.
593	72	77.02	1.44		" " "
616	72	70.90	2.48		Poor appearance, taste tough.
617	72	73.96	1.60		" " " "
628	96	75.49	1.69		Dry and wrinkled, no taste.

TABLE XXX.

STOWELL'S EVERGREEN NO. 3.

Ears husked; stored in refrigerator 20° C.

Serial Number	No. Hrs. Stored	Moisture %	Total Sugars: In green Corn, %	Total Sugars: Calc. to water free basis, %	Remarks
574	24	76.29	1.73		Wrinkled and tasted sour.
575	24	73.87	1.75		" " " "
598	48	67.40	2.59		Dry and Wrinkled.
599	48	79.91	3.02		" " "
622	72	72.52	1.74		Wrinkled, taste tough.
623	72	65.84	1.92		
634	96	74.25	1.81		Very wrinkled.
635	96	74.87	1.49		" "

TABLE XXXI.

STOWELL'S EVERGREEN. NO 3.

Ears husked, wrapped in oiled paper, stored room temperature 28° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars: In green Corn, %	Total Sugars: Calc. to water free basis, %	Remarks
570	24	75.01	1.91		Sample Dry, taste sour.
571	24	77.66	2.36		
594	48	75.94	1.92	.	
595	48	75.62	1.41		
618	72		1.54		
619	72	73.40	1.97		
630	96		1.79		Wrinkled.
631	96	76.86	1.32		"

TABLE XXXII.

STOWELL'S EVERGREEN NO. 3.

Ears husked; wrapped in oiled paper and stored in refrigerator 20° C.

Serial Number	No. Hours Stored	Moisture %	Total Sugars: In green Corn, %	Total Sugars: Calc. to water free basis, %	Remarks
576	24	77 35	1.55		Taste sour, were on bottom of the refrigerator.
577	24	75.56	1.65		
600	48	71.63	1 88		Good appearance.
601	48	78.50	1.72		" "
624	72	78 14	1.53		" "
625	72	76.58	1.74		" "
636	96		1.58		Taste tough and flat.

In Lot No. 1 the sugars present were 4.59 per cent. and 4.74 per cent. Upon standing twenty-four hours about one-third of the sugars disappeared; the next twenty-four hours another loss was noticed, but when the sugars reached 1.80 per cent. no further loss was noted. The taste was not as good after twenty-four hours as when the sample was first pulled and marked. Changes were noted as the length of storage increased. The results do not show any material advantage to be gained either by husking the ear, wrapping it in oiled paper or storing it in the refrigerator. This is noticeable in the remarks on the taste and the percentage of sugars found.

The work shows that corn should not be pulled until ready for use, and should be put on the market and canned with as little delay as possible after gathering it.

A further study of the changes when stored at much lower temperatures would seem desirable, for if the qualities when just pulled from the stalk can be preserved until it reaches the table by shipment in refrigerator cars the early corn of the South would be much more in favor than at present, and this method would also enable merchants to always keep corn in better condition for the city trade. So far, the present investigation would seem to indicate that the ferments work at very low temperatures and that the original qualities of corn will be hard to preserve.

OBSERVATIONS AS TO THE PROPORTIONS OF HUSK, GRAIN AND COB.

It is important for both the canner and grower that the corn will yield as great a portion of kernel as possible for thus the pack per acre will be large and the canner can afford to pay better prices per ton for the corn delivered to the factory.

In order to get some data as to the relative yields of the different parts, the determinations recorded in Tables XXXIII and XXXIV were made. From thes tables we see that the different ears from the Maryland grown corn showed a range in proportion of kernel of about 23 per cent. This seems like a great range and points out the desirability of giving due attention to getting a higher yield of kernel at the same time of improving the other qualities.

TABLE XXXIII.

Showing Weights of Ear and Various Parts and Percentages of Same.

STOWELL'S EVERGREEN. MD.

Serial No.	Wt. Entire Ear. Grams.	Wt. Husk. Grams.	Wt. Husk. Per Cent.	Wt. Cob. Grams.	Wt. Cob. Per Cent.	Wt. Kernels. Grams.	Wt. Kernels. Per Cent.
307	565	133	23.54	165	.....	267	47.26
313	519	129	24.86	180	.....	210	40.46
305	495	120	24.24	165	.....	210	42.42
289	475	185	38.95	140	.....	150	31.58
283	447	187	41.84	130	.....	130	29.08
306	445	115	25.84	135	.....	195	43.82
282	445	145	32.58	120	.....	180	40.45
288	430	195	45.35	128	.....	107	24.88
312	427	135	31.62	142	.....	150	35.15
308	408	121	29.66	145	.....	142	34.80
280	395	115	29.11	125	.....	155	39.24
311	368	103	27.99	135	.....	130	35.33
315	363	88	24.24	128	.....	147	40.50
281	350	140	40.00	115	.....	95	27.14
291	330	124	37.58	110	.....	96	29.09
290	325	89	27.38	100	.....	136	41.85
314	285	73	25.61	125	.....	87	30.53
Average..	416	129	31.01	135	.....	152	36.54

TABLE XXXIV.

Summary of Weights of Ears and Percentages of Various Parts of Corn Grown in Maryland, Together With That From Other States for Comparison.

MARYLAND.

STOWELL'S EVERGREEN.

	Wt. Entire Ear.	Husk. %	Cob. %	Kernels. %
Maximum...........	565	45.35	.....	47.36
Minimum............	285	24.24	.....	24.88
Average.............	416	31.01	.....	36.54

SOUTH CAROLINA.

STOWELL'S EVERGREEN.

	Wt. Entire Ear.	Husk. %	Cob. %	Kernels. %
Maximum...........	465	46.67	.....	44.09
Minimum............	325	22.39	.....	26.67
Average.............	415	31.85	.....	38.12

CONNECTICUT.

STOWELL'S EVERGREEN.

	Wt. Entire Ear.	Husk. %	Cob. %	Kernels. %
Maximum...........	445	36.88	.....	56.51
Minimum...........	310	22.49	.....	29.35
Average.............	381	33.11	.....	38.26

QUALITY OF SWEET CORN GROWN IN DIFFERENT LATITUDES.

In a series of experiments conducted (in co-operation with the Chemical Bureau of the United States Department of Agriculture) to show the influence of environment upon the composition of sweet corn, two varieties of corn were grown at varying degrees of latitude. The results are of particular interest to growers of sweet corn in Maryland, as they confirm the results obtained here and the supposition upon which the work was undertaken that the sugar in corn was dependent upon heat and sunshine, and that as corn was somewhat related to sugar cane that sweeter corn ought to be raised in the South than the North.

TABLE XXXV.

Showing the relative amounts of Sugar in Sweet Corn grown in different latitudes.

STATION	VARIETY OF CORN					
	Crosby's			Stowell's Evergreen		
	Moisture %	Sugars % Edible Condition	Sugars % Calc. to Water free basis	Moisture %	Sugars % Edible Condition	Sugars % Calc. to Water free basis
Clemson College, S. C....	65.84	12.23	35.80	75.54	6.68	27.31
College Park, Md........	....	....	....	78.09	5.78	26.38
New Brunswick, N. J....	....	....	....	69.28	4.26	14.12
New Haven, Conn.......	73.01	7.75	28.64	74.84	5.36	21.30
Orono, Me..............	79.30	6.50	31.40	....	....	....

The above is a summary of the analyses of individual ears of corn made at the time that it was in prime eating or canning condition and represents from twenty to one hundred analyses of each variety made at each station. An examination of the above table reveals the fact that South Carolina, the most southernly located station, produced corn with the highest sugar content, and Maryland stands second. The New Jersey station gave the lowest percentage of sugars, but this was probably caused by a severe drought, occurring just previous to the tasseling of the corn. These results would seem to indicate that sweet corn follows the habits of sugar cane rather than that of sugar beets.

THE COMPOSITION OF SWEET CORN.

The analyses of sweet corn, so far as recorded, have been made by methods which, as already stated, have not been found accurate or satisfactory. Therefore, the following results of the composition of dried, green and canned corn are brought together for comparison.

The complete analysis of Stowell's Evergreen Corn in the green or edible condition showed the following results:

	As Sampled. Per Cent.	Results. Cal. to Water Free Basis.
Moisture........	73.00	.....
Starch and fat...	11.85	43.89
Sugars..........	5.70	21.11
Protein.........	4.59	17.00
Pentosans.......	2.88	10.67
Crude fiber......	1.00	3.70
Ash.............	.98	3.63
Total.........	100.00	100.00

In the following tables are given the results of the determination of protein in the green corn ready for table use, and also the protein and sugar in canned corn.

TABLE XXXIII.

Protein in Green Corn. Summer, 1905.

No.	Name.	Moisture.	Protein.	Calculated to Water Free.
295	Cosmopolitan	79.41	2.90	14.08
298	Monarchie	70.31	3.21	10.81
302	Moore's Concord......	76.36	2.83	11.55
303	Triumph	72.56	2.99	10.89
304	Black Mexican.......	72.74	3.01	11.04
	Average	74.28	2.99	11.07

Canned Corn.

No.	Name.	Moisture.	Protein.	Protein Wtr. Free.	Ttl. Sugars Wtr. Free.
509	Stowell's	76.28	2.79	11.76	9.57
510	" "	76.41	2.86	12.12	9.49
511	" "	78.64	2.37	11.09	10.29
513	" "	76.70	3.24	13.90	9.01
514	Country Gentleman	80.10	2.69	13.52	12.19
516	" "	81.11	2.58	13.65	11.91
517	" "	80.59	2.53	14.04	12.36
518	" "	80.19	2.47	12.45	12.52
	Average.........	78.75	2.69	12.81	10.92

The canned corn was grown by F. P. Roe, Greensboro, Md., from the lot of dried corn which has its analysis given in Table VIII.

Bringing the above results with those for dried corn, as given in Table VIII, together for comparison, we have the following:

TABLE COMPOSITION OF DRIED, GREEN AND CANNED CORN.

Results Calculated to Water Free Basis.)

	Dried Corn.	Green Corn.	Canned Corn.
	%	%	%
Ash	1.94	3.63	.....
Protein	12.52	17.00	12.81
Fat	8.47	.....	.....
Crude fiber......	2.35	3.70	.....
Sugars	5.46	21.11	10.92
Pentosans	7.64	10.67	.....
Starch	61.62	43.89*	.....

*Including fat.

A STUDY OF THE ENZYMES OF SWEET CORN.

ORGANIZED FERMENTS.

To learn if any organized ferments were causing the disturbance which prevented the application of the usual methods of determining sugars in such material two grams of the sample were treated with each of the following preservatives: Alcohol, sulphurous, salicylic, boracic, benzoic acids and formalin were added to samples of the corn. In each case fermentation was prevented; but, while they reduced the action of the enzymes, they did not entirely prohibit, and the results show that an organized ferment was not causing the trouble. At this time samples of the corn were sent to the Bureau of Chemistry, United States Department of Agriculture, where, by following the method employed here, the results obtained were comparable with our own.

CHECK OF THE ANALYTICAL WORK.

No. of Sample.	% Total Sugar.	Analyst.
212	4.85	Bureau of Chemistry.
	4.90	Maryland Experiment Station.
213	7.00	Bureau of Chemistry.
	6.85	Maryland Experiment Station.
214	5.10	Bureau of Chemistry.
	5.15	Maryland Experiment Station.
223	5.05	Bureau of Chemistry.
	5.05	Maryland Experiment Station.
224	4.30	Bureau of Chemistry.
	4.40	Maryland Experiment Station.
225	5.20	Bureau of Chemistry.
	5.15	Maryland Experiment Station.

This was conclusive proof of the correct manipulation of the method.

ACTION OF ALCOHOL ON STARCH AND SUGARS.

Samples of potato starch, prepared in the laboratory, and samples of cane sugar, were treated with alcohol for seven days; but no sugars were formed nor was the cane sugar broken down.

Next the effect of temperature was tried.

Four grams of the sample was treated with thirty cubic centimeters of water and shaken continuously for one hour. This was made up to a volume of one hundred cubic centimeters with 95 per cent. alcohol, and the sugars were determined according to the official method (page 24, Bulletin No. 46) of the Bureau of Chemistry.

Reducing Sugars.	Cane Sugar.	Total Sugars.
3.07	4.65	7.72

Four grams of the sample were treated with thirty cubic centimeters of water and ten cubic centimeters of 95 per cent. alcohol and shaken for one hour. This was made up to the volume of one hundred cubic centimeters with 95 per cent. alcohol, and the sugars were determined as above.

Reducing Sugars.	Cane Sugar.	Total Sugars.
2.69	4.54	7.23

Four grams of the sample were treated with thirty cubic centimeters of water and ten cubic centimeters of 95 per cent. alcohol (added boiling) and boiled for one hour. This was made to a volume of one hundred cubic centimeters with 95 per cent. alcohol, and the sugars were determined as above.

Reducing Sugars.	Cane Sugar.	Total Sugars.
2.50	4.68	7.18
2.50	4.73	7.23

Four grams were treated with thirty cubic centimeters of water and allowed to stand seven hours. Then 95 per cent. alcohol was added to make to one hundred cubic centimeters volume. This stood over night, and then an aliquot portion was taken and the sugars were determined.

Reducing Sugars.	Cane Sugar.	Total Sugars.
7.99	3.14	11.13

Four grams of the sample were treated with thirty cubic centimeters of water and ten cubic centimeters of alcohol. This stood seven hours and was made to one hundred cubic centimeters with 95 per cent. alcohol. This stood twelve hours, and then the sugars were determined.

Reducing Sugars.	Cane Sugar.	Total Sugars.
3.83	4.05	7.88

These results show that enzymes were present and very active. All of the sugar can be gotten in solution by using water as a solvent, or water and alcohol; but in both cases the sugars increased, varying as the length of treatment varies. The alcohol reduces the enzymic action very perceptibly, but does not prevent it. By adding the alcohol and water boiling, and boiling for an hour, solution of the sugars is complete and action of enzymes is prevented.

In Bulletin No. 13, part 9, of Bureau of Chemistry, United States Department of Agriculture, mention is made of the fact that in the common method of separating the carbohydrates soluble in water from the freshly ground grain or flour it must not be forgotten that precautions are not usually taken to prevent the action of natural enzymes, which all cereal flours contain, during the time of extraction. Under the condition in which ordinary aqueous extraction is practiced these enzymes may become active, and consequently a portion of the soluble material secured may be due to this source. In order to avoid the action of the enzymes, Girard proposes the extraction at a very low temperature. This low temperature is secured by conducting the extraction in a vessel which is surrounded by pounded ice.

METHOD PROPOSED BY GIRARD.

The method employed for the extraction of the sugars in the following table was to treat four grams of the sample with one hundred cubic centimeters of 40 per cent. alcohol for two hours. Sample No. 1 was treated with one hundred cubic centimeters of 40 per cent. alcohol, added boiling, and kept at that temperature for two hours. It was then cooled to room temperature, made to volume of two hundred cubic centimeters with 95 per cent. alcohol, an aliquot portion taken and the sugar determined. In Nos, 2, 3, 4, 5, 6, 7 the alcohol was added at 5°C. and kept at this temperature for two hours, being stirred constantly. It was then made to mark with 95 per cent. alcohol, cooled to 5°C., kept at this temperature and allowed to settle. An aliquot portion of the clear solution was drawn off and the sugars were determined as in No. 1. Nos. 8 and 9 were treated in the same manner as Nos. 2, 3, 4, 5, 6, 7, except that they were shaken at intervals of fifteen minutes for two hours. Samples Nos. 4 and 9, after having an aliquot portion withdrawn, had fifty cubic centimeters of 40 per cent. alcohol added to each and were treated again for two hours. The results show that this solution and continued extraction gave higher results and that in the other instances the extraction was not complete.

TABLE I.

Showing the Effect of a Low Temperature.

	Boiling for two hours.	At 5 degress C., shaking constantly for two hours.						At 5 degrees C. shook at Intervals of 15 Min. for two hours.	
Sample No.......	1	2	3	4	5	6	7	8	9
Invert	0.98	0.00	0.00	0.24	0.40	0.00	0.00	0.60	1.00
Cane.............	3.72	3.03	3.08	3.02	2.91	3.16	3.22	3.14	3.06
Total............	4.70	3.03	3.08	3.26	3.31	3.16	3.22	3.74	4.06
		4	4d.					9	9d.
Invert...........	......	0.24	0.28	......	......	......	......	1.00	0.92
Cane.............	......	3.02	3.42	......	......	......	......	3.06	3.84
Total............	......	3.26	3.70	......	......	......	......	4.06	4.76

From the foregoing work it is quite evident that enzymes are present and very active, and that the use of preservatives does not entirely prevent their action, but that temperatures above 80°C., or at 80°C., does prevent their action. In cases where water is used as a solvent the enzymes were most active, an increase of one-half per cent. of sugars occurring after this treatment with water. Alcohol slowed their action very much; but boiling the solution entirely destroyed their active properties. The method of treating samples in the cold is not satisfactory, as all the sugars may not be gotten into solution.

A sample of corn was heated in a water oven for five hours, and the sugars were determined by dissolving the sample at room temperature. By treating the sample for two hours with water at room temperature there was obtained 4.74 per cent. total sugars. Treating it in the same manner for seven hours there was obtained 6.05 per cent. total sugars, showing that heating the air-dry sample did not affect the activity of the enzymes. They were only affected by the heat when in aqueous solution.

ACTION OF THE ENZYMES ON POTATO STARCH.

It was thought advisable to try the action of these enzymes on potato starch, and some of this starch was prepared from the potato. This showed a fine appearance under the microscope.

Four grams of sweet corn upon being treated for seven hours with a 40 per cent. alcohol solution gave 7.80 per cent. and 7.91 per cent. total sugars. By adding two grams of starch to the sample and treating as above indicated 8.38 per cent. total sugars was obtained.

This showed that the starch was attacked before all the available material of the corn sample was used, as 11.13 per cent. total sugars was obtained from the same sample of corn without the addition of starch. An examination of the starch under the microscope showed that the granules had been attacked. They appeared as though they had been etched, some being attacked to such an extent as to give the appearance of lace work. It was thought desirable to try this method on other cereals in comparison with the usual method. Barley, oats, rye and malt were selected. In each case four grams of the sample were treated with fifty cubic centimeters of 40 per cent. alcohol. In Column No. 1 the sample was treated with boiling alcohol for one hour, No. 2 at a room temperature for one hour, and No. 3 at a room temperature for four hours.

TOTAL SUGARS.

	No. 1.	No. 2.	No. 3.
Barley	1.82	2.44	3.62
Oats	0.96	1.64	3.00
Rye	3.50	4.34	5.72
Malt	7.60	10.34	13.80

DESCRIPTION OF THE KERNEL.

The kernel was separated into top, middle portion and germ. The part taken for the top was as indicated above the broken line, the middle portion from between the top line and the broken line surronuding the germ (the shaded portion), while the portion for the germ did not include the entire germ, but the center, in order to avoid getting any of the middle layer.

LOCATION OF SUGARS (2).

Two rows of kernels were taken from an ear of sweet corn and ground, this sample serving to represent the whole grain. The remainder of the kernels were separated, as indicated in the diagram. The following results were obtained and served to locate the sugars more or less accurately.

		% Sugars.	
	Reducing.	Cane.	Total.
Whole grain........	0.84	4.07	4.91
Top of grain.......	1.04	3.73	4.87
Germ	0.00	6.27	6.27
Middle section......	0.32	3.44	3.76

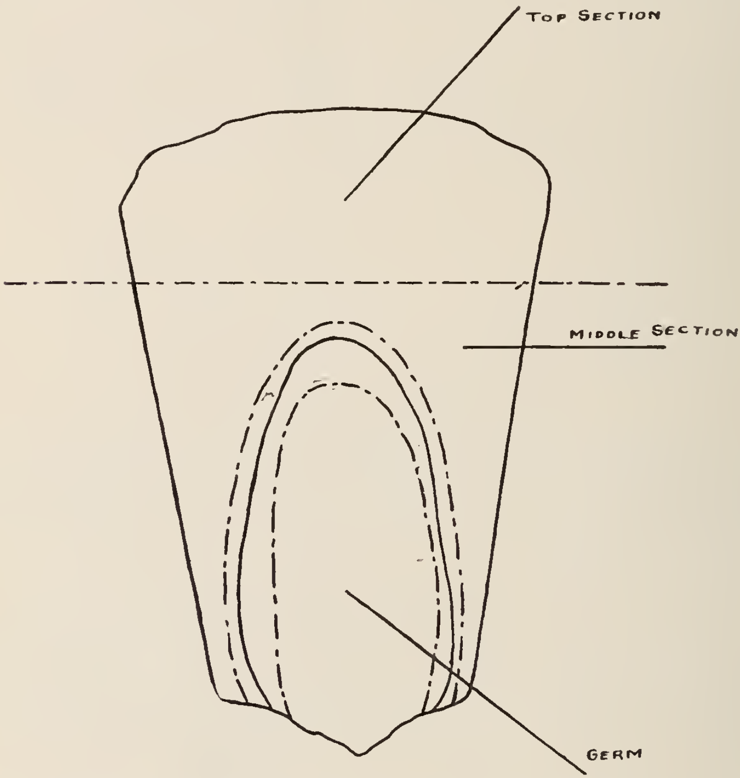
LOCATION OF THE ENZYMES.

In order to locate the enzymes samples of the above, parts were treated with thirty cubic centimeters of water and ten cubic centimeters of starch solution in the cold for four hours.

		Sugars.	
	Reducing.	Cane.	Total.
Whole grain, 10 C. C. starch...	5.16	8.10	13.26
Top of grain, 10 C. C. starch...	7.80	0.00	7.80
Germ, 10 C. C. starch...	11.12	7.80	18.92
Middle section, 10 C. C. starch...	9.00	1.64	10.64

The enzymes are apparently distributed through the entire kernel.

This action of the enzymes is a catalytic one; an instance where the agent does not enter into the compound, but simply is the agent of bringing about the change. An example is where mercury is used as an oxidizing agent in digesting a sample to determine the nitrogen.



There are a number of these enzymes in the body; namely, pancreatin, ptylin and pepsin. In plants it is usually a diastase. One of their characteristics is that they do not increase in numbers.

VARIETAL RESISTANCE TO INSECTS.

In the season of 1905 a thing of especial interest was noticed. Two varieties of corn, Stowell's Evergreen and Crosby's Variety, were planted on adjoining plots. The Crosby's corn had over 50 per cent. of the young plants destroyed by wire worm, and the Stowell's did not suffer a loss of 2 per cent. from them. Both varieties were on land which had received similar treatment for a number of years and they were planted at the same time; in consequence, the failure of the worms to damage the Stowell's variety was attributed to varietal resistance.

THE MARYLAND
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By B. E. Porter.*

THE GROWING AND FATTENING OF BEEF CATTLE IN MARYLAND—PRESENT STATUS OF THE INDUSTRY AND SUGGESTIONS FOR ITS IMPROVEMENT.

Introduction.

Within the last quarter of a century the production of beef in the United States has made wonderful advancement. The number of cattle handled at the great livestock markets has been increasing from year to year, so that the commercial magnitude of the industry is now very difficult to comprehend. One packing firm alone at Chicago transacts business amounting to a million dollars every twenty-four hours.

But beyond this activity in the commercial centers is the activity which starts on the farm with the production of the crops and feeding the cattle. The question of economic production is no longer an easy one for the cattlemen to solve. Changed conditions have introduced new factors, which have much influence on the profits of the industries.

The object of investigating the beef-cattle industry of Maryland has been to study the methods and practices of the growers and feeders of beef cattle, learn of the actual conditions of affairs and then, from the information and data, collected from the various sources, to offer, if possible, some suggestions which might aid in bringing about an improvement of conditions which would result in increasing the industry.

The Extent of the Industry.

The growing and fattening of beef cattle is one of the largest industries in the United States, and, according to the last reports of the Bureau of Animal Industry, the number of cattle, other than milch cows, has increased since January 1, 1900, from 27,610,054 to 51,556,000, with an increase in valuation from $689,486,260 to $881,557,000. The figures are large, and will at once give an idea of the immense growth of livestock production throughout the country. Maryland

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does not have so important a part in the beef industry as some of the other States. In number of cattle and total value, Texas and Iowa lead all the other States. The following table will show the total number, farm value and average price of cattle as given for Texas, Iowa and Maryland on January 1, 1906:

State.	Total No.	Farm Value.	Av. Farm Value.
Texas	8,579,739	$101,026,428	$11.78
Iowa	3,432,832	71,299,918	20.77
Maryland	135,319	2,458,068	18.16

Maryland's relative position in the livestock industry is better than the above figures indicate, when it is remembered that Iowa devotes nearly 25 times and Texas 100 times as much area to their production as does Maryland.

The following, taken from the census report of 1900, will show the distribution of cattle over the State:

TABLE I.

Cattle kept in Maryland for Beef Production. Counties.

COUNTY.	Calves under 1 year.	Steers, 1 and under 2 years.	Steers, 2 and under 3 years.	Steers, 3 years and over.	Heifers, 1 and under 2 years.	Cows, 2 years and over.
Allegany County....	1546	636	476	128	868	417
Anne Arundel County	868	243	204	721	386	162
Baltimore County...	4134	309	386	267	2984	799
Baltimore City......	173	18	31	714	55	224
Calvert County......	939	176	218	1177	163	89
Caroline County.....	1175	154	78	30	432	176
Carroll County......	3798	333	410	58	2928	301
Cecil County........	3209	407	357	177	2021	356
Charles County......	2254	673	726	1573	793	223
Dorchester County..	2060	383	355	1489	797	641
Frederick County...	6776	2332	1976	269	4050	587
Garrett County......	4570	2855	1882	393	1573	1097
Harford County.....	3738	612	2049	1380	2467	343
Howard County.....	1275	263	658	499	822	135
Kent County........	1921	116	75	65	908	474
Montgomery County.	3205	968	1927	1927	1892	449
Prince George's Co..	1342	251	224	349	598	321
Queen Anne's County	2285	164	96	164	1116	334
St. Mary's County...	1404	420	488	1821	475	173
Somerset County....	809	167	121	406	331	214
Talbot County.......	1691	78	104	37	691	321
Washington County.	4439	1809	906	91	2341	345
Wicomico County....	1005	147	139	426	2433	146
Worcester...........	2006	416	347	581	3385	1450
Total..............	56,322	14,010	11,235	14,752	28,506	9,677

The cattle fed in Maryland are handled chiefly in small bunches. This is due to the fact that the farms are relatively small, and that individual farmers are doing the work, and that there are no large organized companies. The number fed by any one man varies; the usual number is from sixteen to thirty, or enough to make a car-load. Still a few men have equipment and capital enough to handle as many as from one hundred and fifty to three hundred annually.

The opportunity for increasing the output of finished cattle from the State will be mostly by increasing the number of farmers engaging in the industry, rather than by increasing the number of cattle fed by any one man. To do this there should be some detailed information disseminated concerning the incentives, opportunities and profits to be derived from the business.

Advantages and Disadvantages of Cattle Feeding in Maryland.

The experiences related by some men engaged in the business are very interesting, since they explain in a measure a few of the conditions which govern the extent of the enterprise. First, it may be said that a certain amount of profit must be assured, and since this profit is variable, due to the changing market prices, there is an element of speculation, which enters in and becomes quite sharp for the shrewdest of stockmen. The fear of not making a profit keeps many out of the business. Little training and skill in the methods and practices of feeding, so as to get the right kind of finish when prices are good, handicaps others. Then a certain amount of working capital must be in readiness to take advantage of bargains, and stem the tide of unfavorable prices for finished cattle. Because of the uncertainty connected with a part of the work, men with limited amounts of capital are finding other and surer investments.

There are tenant farmers who could and would feed cattle, if they had the capital to buy them. Some of these have co-operated with men who have cattle, and are looking for labor. Thus a system of feeding cattle on the shares is the result. Several reports speak favorable of such an arrangement. The management under such a system is for the tenant to raise and feed the grain and roughage, look after the farm and fences, and care for the stock, while the landowner has the land and livestock as capital to balance against the work of the tenant. Co-operation on the part of capital and labor, with an equal division of the profits, is proving as satisfactory to some farmers as it is in some other lines of business.

On most of the farms of the State there is more or less roughage to be utilized in some way or other. All the hay, straw and fodder do not find a ready sale. Manure is needed to build up the fertility of the soil. Therefore cattle feeding is a natural consequence. But it is not so much the utilization of the roughage as it is the making of manure for the farms that makes men consider most seriously the problems connected with the feeding of cattle. Men are realizing the importance of barnyard manure in crop production, especially on the lighter and

sandy soil farms. Those who have tried the manure are fully convinced. They find manure puts life into the soil, and does for it what commercial fertilizers never can do. Fertilizers are good in their place, but the manure made from the feeding of cattle, and retained on the farms, is the cheapest and best of fertilizers.

Many troubles about fertilizers, costs of producing crops and labor are being solved by those who feed cattle.

In fact, cattle feeding utilizes the grain and roughage where the manure should be left, lessens the expense of hauling to and from the farm, and secures better and more competent labor by furnishing employment the entire year.

CHECKS ON THE EXTENT OF CATTLE FEEDING IN THE STATE.

While beef production is quite a large industry in the United States, there are a number of things which hold in check the progress and extent of the work in Maryland. First, there is a lack of good cattle for feeding. In this particular Maryland is not alone, for stock shippers report a heavy demand throughout the East for good cattle. The scarcity is quite perplexing. Conditions have changed in the ranching part of the country. So great has been the demand for homes, that the land has been settled up and divided into small holdings. This change in land ownership has decreased the amount of feeding cattle produced.

Moreover, to meet this scarcity of good cattle, it will be well for men who have the rough pasture land to deal more seriously with the problem of growing their own feeding stock. In other words, adopt the policy of many farmers of the Central Western States. Conditions in some sections are even more favorable here than there for the growing of beef from the calf to the block. A few have adopted such a plan, and are getting along quite successfully.

Another c ck to the extent of cattle feeding is the increased price of feed stuffs. Hay and grain of all sorts have a much higher market value than a few years ago.

The demand for dairy products, especially near the larger cities, commands marked attention. The supply of milk going into Washington, Baltimore and Philadelphia is truly great. Then the farmers having good railroad facilities to these markets find it very profitable to engage in dairying. And while this industry needs encouragement, and is growing and thriving, yet it cannot be said that dairying is always a success. The conditions sometimes favor another kind of enterprise, but on account of the attractive market quotations for dairy products, the feeding and growing of beef cattle receives very little consideration.

LABOR FOR THE FARM.

One of the most serious handicaps to cattle feeding in this State is the ever-present scarcity of good, competent and reliable farmer labor. A successful feeder should be a man that is able to do more

than carry out feed to the stock, and clean out the stable. He should be a keen observer of the needs of the animals in his care. It is, indeed, a grave misfortune that only a few of the right sort can be found. The negro who was once employed is going to the city. Factories of all sorts are calling for men. If labor was available, cattle feeding would increase, since there are men with good farms and ready capital to finance the enterprise. Almost everywhere much interest was manifested in the question of satisfactory labor.

DESIRABLE TYPE OF CATTLE.

The best type of feeder has a conformation which will allow the production of a maximum amount of the high-priced cuts of beef. The good feeding steers are those which are comparatively wide, round and deeply ribbed. The animal which is upstanding, light in the flank and shallow in heart girth seldom makes a good feeder.

Figure 1—A Poor Feeder.

In form the feeder should be broad and deep in front, low set and blocky built; he should carry out strong and wide in the hind parts as well, and be deep and low in the flank and twist. The head is usually a condensed reflexion of the rest of the form. A broad, short head is associated with a thick, wide, low-set body, and the narrow head with slim face is generally accompanied with more narrowness and greater length of legs and body.

It will be found frequently that the narrow-chested animal is a poor feeder, which makes but little progress in proportion to the feed that it eats. The animal with the deep, wide chest on the bottom, and not shrinking away behind the forelegs, is one strong in vital force and constitution, and is not deficient in capacity to make feed into flesh and fat economically.

An important factor which enters into the value of the finished steer is quality; so as to have quality when fattened, the animal must have much of it before it goes into the feed lot. Quality in the steer means fine bone, soft, mellow hide, and fine, silky hair, while a very rough, heavy frame, coarse joints, prominent, ragged hips, and rough, open shoulders are such attributes which are the most striking evidences of deficiency in this feature. Quality has to do also with the meat and the distribution of fat. Meat of a good character is nicely marbled with fat—that is, the fat is well interspersed between the muscular fiber. Such meat has a richness and juiciness which is much sought after by the consumer. Now, furthermore, the finished steer, to have high quality, must have not only fine bone, a mellow hide, and fine, silky hair, but also a deep, even distribution of flesh, which is mellow and elastic to the touch. There should be no evidence of patchiness, either about the last ribs or the tail head, for such shows an uneven distribution of fat, which is undesirable.

THE KIND OF CATTLE FOUND ON MARYLAND FARMS.

Generally speaking, the kind of cattle found in the feed lots and pastures was not of the best type. So many cattle were lacking in width and depth of body, high standing from the ground, and very deficient in muscular development. Quite often there was a good bony frame, with sufficient quality, but there was not the large heart girth, with the full crops so much desired in all good feeders; the ribs were deficient in their width of arch, the loins were narrow, and, in fact, the hind quarters were light, narrow and wanting in the depth which is found with the low flank and deep twist.

Experience has taught but few Maryland men how to handle and fatten the well-bred and muscular steer. The chief demand all along has been for the thin steer at a low figure. This, of course, has helped to fix the type of steers going into the feed lot.

The type in many of the herds lack uniformity, for even in the small bunches several different types were found. In some feeding lots a few of the low-down blocky types were in with the others of the larger, heavier-framed sort. Uniformity in type, size, weight, and even color, in a herd of well-finished steers has immeasurable value, which should be duly recognized.

The weight most commonly desired, for a short feeding period, ranges closely around 1,000 pounds. Especially is this true for winter feeding, and when cattle are bought in November. If bought for summer grass feeding, or if bought in September for early winter feeding, a steer near the 800 to the 850 mark is bought.

Just recently a few men, by reason of the scarcity of the larger animals, have bought young calves. Not much attention is given to

Figure 2—A Steer Fattened in Montgomery County, Md.

age and weight, if quality and prices are good. And again, it would be well that more attention to be given to quality and the proper type in conformation than to age and weight.

STEERS OF DIFFERENT BREEDS.

With the improved breeding of livestock, a most useful and profitable type of animal has been obtained for different purposes. Certain breeds of cattle have been bred, either for milk or beef production. Now for beef there are the Shorthorns, Herefords and Aberdeen Angus, which are the most generally known. These breeds have been developed especially for beef, and whenever a herd has much of the blood of either of these breeds in it, the type of the good feeder is generally found. Then aside from having a conformation peculiarly adapted for beef production, it is found that these breeds have different characteristics which feeders have learned to recognize and value highly.

As beef producers, the Shorthorns rank in the first class. In all the leading fat stock shows of Great Britain and America, Shorthorn steers far outnumber any other breed, while in the stockyards Shorthorn grades largely predominate.

Shorthorns are good lot and stall feeders; they make rapid gains, and show fairly good dressing percentage; they are a little inclined

Figure 3—A Typical Shorthorn Steer.

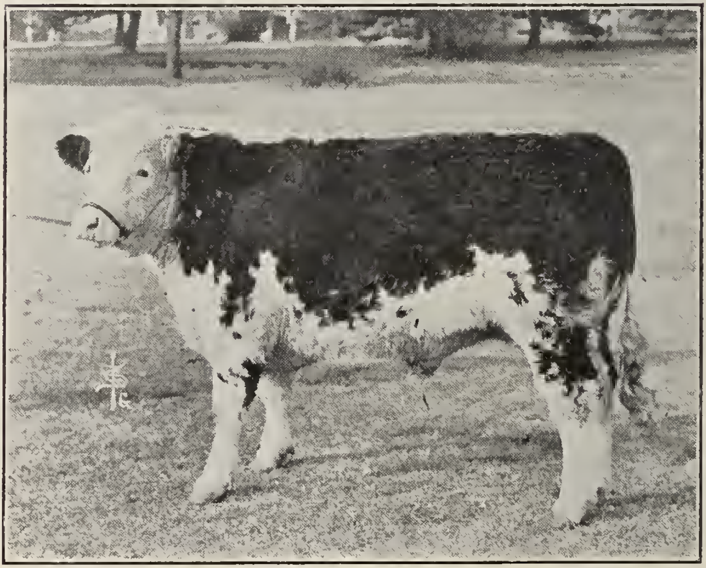

Figure 4—A Typical Hereford Steer.

to be leggy and upstanding, which is against them, but they are quick to adapt themselves to any changes and environments.

The Herefords as meat producers have high rank. These cattle have made marked improvement within the last twenty-five years. The breed is criticized for having an excess of throatiness, dewlap and lack of development of rump and hind quarter. The Hereford steer is noted as an excellent grazing animal, and in this respect has no equal. Herefords mature much more rapidly than Shorthorns, and are much in favor for the production of the so-called "baby beef."

Figure 6—Kambrick's Car-load of Fat Steers (Aberdeen Angus) at Chicago Live-Stock Show, 1906. (Photo by Porter.)

In the show ring the Aberdeen Angus steer has made a remarkable record. No other breed has made so fine a record in winning the high honors at the Chicago International Livestock Show. The breed has won many highest honors, not only in champion fat steer classes, but also in carload lots. The steers are excellent feeders, but must not be too closely confined; they are more or less wild by nature, so that strangers and dogs must keep away. This breed appears to stand shipping by rail somewhat better than the other breeds of cattle. They are not so well adapted to the range as the Herefords, but mature early, and are highly prized by many growers of "baby beef."

Figure 5—A Typical Aberdeen Angus Steer.

SOURCES OF SUPPLY.

Where to secure good high-quality feeding cattle at reasonable prices engages the attention of every stockman. Where to go is quite perplexing. The markets are searched everywhere to supply the demand, and as yet it cannot be said with much certainty that one market is at all times better than another. Doubtless, at stated seasons of the year one or more markets are better than others for some grades or classes of feeding stock.

The outlook for feeding cattle is very unsettled in some sections of the State, by reason of experience and reports which verify the statement that cattle from certain markets or districts are better feeders, and will finish easier than cattle from other parts. Such reports are always valuable, but when the supply of stock is limited, more than one market must be investigated. It always pays to keep in close touch with the larger markets, because as a usual thing a better quality of animal can be obtained there.

The supply of the two-year-old steer, so much in demand at the present day, is not so great as formerly. At the stockyards of the large markets of the west many of the two-year-olds are coming in as the finished product, and are ready for slaughter. If such a steer is there unfinished, and has quality and breeding, it is usually because his owner has been unfortunate in not having feed to finish him. The price of such stock is unusually high.

The greatest market for feeding cattle is Chicago. Other good markets which are patronized by Maryland feeders are Southwest Virginia, St. Louis, Kansas City, Buffalo and Pittsburg. Some cattle have been secured on the market at Lancaster, Pennsylvania.

Stock coming into the State are classified by many men not according to their condition or quality, but according to the section of country or market from which they have been shipped. Most of the cattle from the west are known as Western or Chicago cattle; others are known as Southwest Missouri or Texas cattle. Stock from the north are called either Buffalo or Canadian, and may acquire a new name, if they stop at Pittsburg or Lancaster, Pennsylvania. Then, cattle from Tennessee, Virginia and West Virginia are classed chiefly as Virginian cattle.

The subject of acclimation has been receiving much attention in connection with the source of supply. For short-winter feeding there is not so much preference noted, but when the cattle are to be pastured, particularly in the warmer counties of the State, it is to be expected that cattle grown in a similar climate will do best. This being so, it is natural that Virginian cattle will acclimate easiest in most parts of Maryland.

In some localities there has been a decided preference expressed for cattle coming either from the West, North or from Virginia.

When men are catering to a demand for a handy weight bullock the Virginia steer is put into the feed lot; he makes a smooth finish on light gains, and also finishes easily if kept on a summer pasture. Some claim that the market in Washington, Baltimore and Philadelphia for the handy weight bullock has been built up largely by the use of the Virginia steer. The feeders producing the heavy beef, and supplying some of the export trade, are obtained chiefly from the West and North. These cattle do not always acclimate easily, but often are the heavier gainers. It takes more than a little warming up to get him in shape for market; his frame has been built for a wealth of fat and flesh, and therefore takes more time than many of the speculative feeders care to give them.

Several parties who handle cattle in small bunches have expressed a great deal of dissatisfaction with the stock which they have ordered through commission firms. The quality of the animal was not what they expected; the weights were either too heavy or too light, or one or more animals were out of class with the rest.

Local commission men are an advantage many times; they will ship in several loads of cattle, and then allow the farmers to come and select their own feeders. At times a few men will agree to bear the expenses of one of their number, who is competent to select feeding cattle, to go and buy their cattle. But some men, who generally feed a large number, and are confident in making a saving, do their own buying, and also make their own sales.

Freight rates, distance from market and driftage each have an important bearing on the traffic and have their influence on the cost of transportation. When looking over the reports of farmers, it is difficult

to make a comparison, since so much has been said about rate discrimination. Rates per hundred from Chicago to Baltimore have been 25 cents, from Buffalo to Baltimore 19 cents, from Chicago to points in Washington and Frederick counties 25 cents, and from Buffalo to Garrett county 17 cents. A few loads from Kansas City to Frederick county have come in at 21 cents per hundred. In a few instances it is very evident that distance does not count for so very much.

The driftage on the long hauls is by far the greatest. The amount may vary within wide limits, and is the result of the care the cattle receive, both before starting on the journey and while en route.

RANGE OF PRICES FOR CATTLE.

Cattle.

	Native Steers 1500–1800 pounds.		Native Steers 1200–1500 pounds.		Poor to Best Cows and Heifers.		Native Stockers and Feeders.		Texas and Western Steers.	
Range, 1906 ..	4.75a	10.50	3.90a	17.00	2.40a	6.60	1.75a	5 10	2.90a	6.35
Range, 1905...	4.40a	8.65	3.00a	8.45	2.25a	6.80	1.50a	5.45	2.60a	5.25
Range, 1904...	4.35a	10.50	3.35a	12.25	2.00a	7.50	1.50a	5.50	2.40a	5.65
Range, 1903...	4.10a	7.35	3.35a	8.35	2.50a	5.50	1.50a	5.20	2.55a	5.10
Range, 1902...	4.25a	14.50	3.60a	9.00	3.35a	8.25	1.90a	6.00	2.55a	7.65
Range, 1901...	4.75a	9.30	3.60a	12.00	2.00a	8.00	1.65a	5.15	2.75a	5.75
Range, 1900...	4.70a	15.50	3.90a	11.00	1.75a	6.00	2.10a	5.25	3.00a	5.90
Range, 1899...	4.60a	8.50	4.00a	8.25	2.00a	6.85	2.50a	5.40	3.10a	6.75
Range, 1898...	4.10a	6.25	3.80a	6.15	2.00a	5.40	2.50a	5.40	3.15a	5.40
Range, 1897...	4.00a	6.00	3.35a	6.00	1.75a	5.40	2.40a	4.75	2.75a	4.90
Range, 1896...	3.40a	6.50	2.90a	6.25	1.75a	4.40	2.20a	4.10	2.10a	5.50
Range, 1895...	3.60a	6.60	2.90a	6.40	2.00a	5.75	2.25a	5.15	2.25a	5.75

Valuation Cattle, 1906....................................$163,670,389.00
Valuation Calves, 1906.................................... 4,520,130.00

SYSTEMS OF FEEDING.

The system or method of getting cattle ready for market varies in some particular in nearly every section of the State. Climate conditions, and the varied character of the soil, its topography and adaptability for certain crops, and field management, make it advisable to pursue different methods.

The system of feeding cattle, though varying as to minor details, may be divided into two classes, namely, the short feed and long feed. In the short feed the cattle are put on a full grain ration as soon as possible, and are kept only for a short time, usually from three to six months. In the long feed the cattle are kept on rough feed, with very little grain during the first winter, pastured during the summer, and finally sold from the grass in the fall, or put on a grain ration and sold in the winter. The length of time given to a long feed is generally about twelve or more months.

SHORT FEEDING.

Many of the cattlemen in Maryland follow the short feeding system. In truth, most of the cattle sent to market from the feeding lots have been put through on a short feed. This is naturally to be expected, because very much of the land is cropped each season. Then, in order to feed up the roughage, and make manure, cattle are fed during the winter months.

This system of short feeding naturally divides itself into three heads: First, grass; second, stall or lot, and third, grass and stall in combination.

In the western part of the State, especially in Harford county, a few men who have much rough pasture land buy their cattle in the early spring, and make use, if need be, of a little corn-fodder, or other roughage, until grass comes. The cattle are then turned out to pasture, and fattened on the grass as best they will, without any grain. With good grass this method has been reported to make fairly good rent for the kind of land used. When grain was fed to the cattle on grass the gains and prices did not compensate the expense incurred.

Most of the cattle fattened in Maryland are fed in stalls, open stables and sheds, with an adjoining lot or pound. Most of the stall feeding is carried on during the winter months. The feeding is commenced in November, or the first of December, and the cattle are finished between April 1 and the first of June. Some bunches are in such a condition that they can be finished, ready for market, in 60 to 90 days.

The grass and stall in combination feeding commences usually in September, and the cattle are finished by Christmas or the first of January. In this way the cattle get filled up, recover from the loss in driftage, and make some gain on the fall pastures before the grain feeding commences.

LONG FEEDING.

Only a small per cent. of the cattle feeders of the State keep cattle feeding as long as a year. This class of feeders are found chiefly in Montgomery, Howard and Harford counties, while those who raise their own cattle are found in Garrett, Washington and Talbot counties.

Under this system the cattle are pastured through the summer months. The pastures in the sections which follow this system are permanent in character, and the growth consists mainly of Kentucky blue grass and white clover. These pastures are located on the meadow lands, and on the hill lands that are too rough to cultivate. In many cases they have never been plowed, and in most cases have been in grass many years. In the mountain sections cattle are grazed on lands which are growing timber, with much undergrowth of brush.

The class or grade of cattle used for long feeding differs from those used for short feeding chiefly in their weight. The long-feeding period cattle go into the lot about 100 to 200 pounds lighter than for the short period. In each case the same quality breeding and conforma-

tion is desired. Cattle fed for a year or more make considerably greater total gains than the short term feeders. As much as five hundred pounds have been reported in a few instances.

SHELTER FOR CATTLE.

The shelter problem in cattle feeding is of importance, since it influences materially the cost of labor and other questions which effect the cost of producing beef. Cattle should be protected during unfavorable seasons of the year, but the question is what is necessary and sufficient to give the animal comfort, and yet not overdo the thing? Too warm quarters are just as harmful to the health, and to the rate of gains, as not warm enough. There should be, however, sufficient protection, so that the animal will not need to use much more food for heat production to keep up the normal temperature of the body than is naturally radiated during the rapid assimilation of food. The animal, after having been fed for beef for some time, has more or less fat distributed over the body just beneath the skin, and this gives added protection. But, when providing shelter, the animal must not be given uncomfortably warm quarters, because he will lose appetite, become languid and lose weight. Quarters for fattening cattle should be dry and well ventilated, rather than very warm.

For stock cattle the situation is different. They are not forced along with grain, and hence do not have a cover of fat as a protection. Director Waters, of the Missouri Experiment Station, after studying the shelter problem for several years, concludes from experiments that cattle living on rough feed and little grain must have a good, warm, well-ventilated barn, and that fattening cattle do best in open sheds. The Pennsylvania Station† has also done some valuable work on the subject of sheltering and feeding cattle, from which they concluded after three years' work that the gains made by fattening steers are not increased by warm quarters. Stables cannot be too cold for fattening steers, provided they are kept dry and well bedded.

BUILDINGS AND BARNS USED IN FEEDING CATTLE.

The character of the barns and sheds for feeding cattle varies considerably in different parts of the State. The climate of the western counties has caused farmers to construct large bank barns for the sheltering of their crops and livestock, while farmers in Southern Maryland, and on the Eastern Shore, have built less expensive structures. Simple sheds have sufficed quite well. The open shed for fattening cattle is found in many places, and, all things considered, is the best when cattle are fattening and taking on heavy and rapid gains. At one place a small feeding lot entirely shedded over was found. Some-

†Bulletin No. 74 of the Pennsylvania State College Experiment Station.

straw sheds are in use, and quite a little shelter is furnished by stacking the straw in the feed lot about the barn.

Few barns and little shedding are used during the summer months for beef cattle, but in the winter most of the feeding is done within barns. Some of these barns are fitted up with stalls and stanchions, in which each animal is fastened for the night at least. Others have small enclosures, in which a number of steers are limited as to space, and not allowed to move about with much freedom.

It is quite evident that the amount of shedding and barn shelter required for fattening cattle is not definitely determined or well understood, because it is a frequent occurrence to find expensive large barns in localities where open sheds would have answered sufficiently well. When the weather is warm and mild it is far better for the stock to be outside than housed up in a damp, dark barn.

HANDLING AT STABLE.

There are several methods in use for handling cattle about the stable. One is to keep the cattle in the barn over night, and then allow them to run on an outside lot during the day, if the weather permits. Another practice is to keep the cattle fastened in the barn all the time, except for a short time when the stable is cleaned. And still another practice is simply to fasten the cattle while they eat their grains; the rest of the time they are given the run of a small lot or pound, and open shed. The stables of the first two methods have the manure removed daily, which of course necessitates much daily labor. In the last method there is no stable to clean. The place is kept clean by liberal applications of straw, or the waste from shredded fodder.

When handling cattle about a barn it is a mistake to keep them fastened in lock stanchions any length of time. A steer to do his best must have some freedom and exercise. At the same time precautions must be taken lest the lot or stable be too large, so that the exercise is excessive, and thus the food consumed is used in energy, instead of producing flesh and fat. The least expenditure of energy for maintenance occurs when the steer is lying down comfortably; consequently the quarters should be provided for this necessity. Feed steers plentifully; give them a good, dry, soft bed, and they will lie down, stretch out to the feeder's delight, be content, and make rapid and substantial gains. Comfort and contentment are little thought of by those who allow the pound or lot to become so filthy that the steer will not lie down. A constant supply of good, clean water, and plenty of salt always within reach, also contribute to the steer's comfort, and increase the farmer's returns.

FOLLOWING CATTLE WITH HOGS.

Keeping hogs in the feed lot, stable or pasture, to follow after cattle, is not a general practice in Maryland. The few men who have kept hogs in this way give very favorable reports. One instance shows

that a good share of the profit of the feeding was made by the hogs. This feeder reported between eight and nine dollars for each hog on eighteen head, which had followed twenty-four steers. The number of hogs per head of cattle depends pretty much on the character of the feed given. When the grain was ground into meal, or when the corn was fed in silage only about one hog for every four to six steers was kept, but with crushed corn or corn-fodder one hog followed two or three steers. A few hogs in a pasture will work over the droppings of the cattle, and prevent the rank growth in spots which cattle will not eat.

PASTURING CATTLE.

Beef cattle which are carried through the summer are mostly fed on pastures.

The permanent pastures are mostly composed of Kentucky blue grass and white clover. In some sections the white clover does not flourish as well as in others. When white clover is absent the farmers do not regard the pastures as highly, as they have noted that cattle do not do as well as when on the pastures containing clover. Red top grass is found to some extent in many pastures, particularly in the Southern and Eastern part of the State.

On the lighter lands of Southern and Eastern Maryland the Bermuda grass is found widely distributed, and makes a good pasture.

The Japan clover (Lespedeza Striata) is found wild in the pastures in many parts of the State. It is quite nutritious, and is especially valuable as a mid-summer pasture.

The marshes and land along the rivers and creeks in the tide-water sections grow an abundance of coarse natural grasses, as do also the glades in the mountains of Western Maryland. These grasses produce good early and late pastures, and also a fairly good hay, if cut at the proper season. Meadows and land which has been cut for hay and wheat stubble afford considerable late summer and fall pastures. In sections where fodder is topped the part that remains in the field gives fall and winter pasture.

The quality of the pasture varies considerably with the soil, and the way in which it has been cared for. The best natural pastures are found in the Northern and Western parts of the State. In these sections woodland or land which has just been cleared, if grazed, will soon become set with grass and clover, and in a few years have a good sod, which will afford lots of feed. Some farmers give their pasture lands good care, and look after the keeping down of obnoxious weeds. In a few instances farmers give the pasture lands occasional top dressings of lime, manure or fertilizer, and find that such treatments pay well. This practice should be more general.

Pastures should not be grazed too closely in the fall, but a slight growth allowed to accumulate to serve as a mulch for winter protection, and this will also induce an earlier start the next spring.

The amount of feed produced per acre, and consequently the area required for an animal, varies considerably with the seasons and the condition of the soil. Some pastures will summer one steer per acre, while other pastures will require two to four acres per steer.

The length of the pasturing season varies in different parts of the State, and also with the weather conditions from six to nine months. The duration of life of a pasture varies with the soil conditions, and the treatment to which it has been subjected. There are many pastures in the State ranging from 30 to 100 years old; but usually land is left in pasture only three to five years.

Usually it would pay farmers to make a greater effort to get good, permanent pastures established, and then take good care of them, so as to get them to last a great many years, rather than to be continually trying to get them.

SUPPLEMENTING PASTURES BY GRAIN OR OTHER FEED.

As a rule cattle are fed nothing else when on pasture; yet some farmers have found that the feeding of some grain, daily, will pay. Some feeders give some silage or soiling to cattle during the part of the season when the pasture becomes short.

Cattle which are sold to the butchers directly from the pastures are usually fed some grain during the two or three weeks just previous to shipment.

Some stockmen claim that it requires just about so much grain to finish cattle for market, and that if this is given gradually a little grain daily, all through the season, they are in better condition to go on to grain feeding in the fall.

GAINS MADE ON PASTURE.

The gains made on pasture are usually very satisfactory, and will average better than those made by stall feeding. One man reported that a lot of steers which had been wintered on sweet corn fodder made a gain of three pounds per day on the pasture. This was an exceptionally good pasture, and returned to its owner from $1.65 to $4.00 net per month on each bullock.

Cattle wintered on silage will not gain as fast when turned on to grass as those fed on dry feed, but the silage-fed steers come through the winter better than those on dry feed.

FEEDS USED.

Grains.

The great feed for fattening cattle is corn. The grain and forage of this widely grown farm product is fed in many ways to stock, and only in a few instances are cattle put on the market without having had some corn. Where oats is grown in the crop rotation they are fed ground up with corn into what is called mixed feed. Very little wheat or rye is ever fed.

In making up rations for cattle, corn is often fed alone, but this system is not so popular at present, and small amounts of commercial feeds are used. Bran is used only in conjunction with corn meal. Formerly cottonseed had a place, but now, on account of its high price, most men have abandoned its use almost entirely, except to put on the market finish. One or two stockmen were giving a rather heavy ration of cottonseed meal with corn silage. Another man was using dried brewer's rye grains, which contained 19 per cent. of protein and five per cent. fat. These were shipped to his station for $15 per ton.

While some corn is bought by feeders who do not raise enough on their own farms, yet bran and cottonseed meal have the largest sales as feedstuffs.

ROUGHAGE.

The objects in feeding having been to make use of the rough forage there is little, if any, bought for the feed lot. Corn fodder and corn stover are the principal stuffs that cannot be easily sold, and must necessarily be fed up and made into manure. These with timothy hay, clover, alfalfa, silage, either of corn, sorghum or pea vines, and the straw from oats, wheat and rye, make up most of the available roughage. Timothy hay, oat, straw and corn fodder constitute the bulk of the roughage in Garrett and Washington counties. In Frederick and Carroll counties a wider variety is found. Here the pea vines left from the canning factories are made into silage. In Southern Maryland, and on the Eastern Shore, cow-pea hay and cow-pea pastures are found in quite extensive use.

The farmers of Maryland can grow quite a variety of legumes, and through them grow considerable of the protein which they require for balancing rations, and thus save the purchasing of the expensive by-product mill-feed.

SILAGE.

The success attending the use of silage in the dairy business has created much interest among beef-cattle men. Silage furnishes a succulent food, which is quite essential to the dairy cow in keeping her digestive system in good condition. The same will be found true for the beef animal. Twenty pounds of silage per day will supply all the bulk and water needed in a fattening ration. The other roughage may consist of either long fodder or mixed hay. The economy of using silage for fattening purposes is well brought out by Prof. A. M. Soule, at the Virginia Station, in Bulletin No. 157, in which he states the following conclusions:

"There was a difference of from .3 to .5 of a pound of gain per head per day in favor of the silage-fed cattle. They also finished out better, and in any discriminating market would certainly bring a better price than the dry-fed cattle.

"Of the three forms of roughage fed, the silage was eaten with the greatest relish, and there was absolutely no loss, whereas with the stover the loss amounted to 13.5 per cent., and with hay 4.16 per cent. Where a larger number of animals are fed this would make a considerable difference in the cost of ration, except that the shredded stover can be utilized to advantage for bedding."

Silage as it is put up today is better than when the practice was first started. Good silage of corn is made when the grain has passed the milk stage, and has commenced to glaze a little. Silage is made also from sorghum, corn and cow-peas and pea vines.

CORN STOVER.

Corn stover is used both shredded and unshredded. Ordinarily the cattle will waste a considerable quantity, whichever way it is fed. The shredded fodder is prepared because the cattle eat a greater percentage of it, and the manure is handled more easily. Fodder is often fed on the ground in the open pasture field to save the hauling of manure.

There is a saving, however, in having the fodder shredded. Usually the feed is taken care of earlier, and there is less exposure to leaching rains and weathering processes. Again, more feed can be put in a smaller space, thus requiring less storage space.

GAINS OBTAINED.

The amount of gain in weight varies with the length of the feeding period, the class of cattle and the ration given. Seldom is there less than 200 pounds gain, and sometimes as much as 400 or 500 pounds are obtained. A few who make a specialty of supplying the handy weight butcher trade simply put on enough weight and finish needed to make the animal sell well. Such light gains are made on those feeders which are smoothly turned, and are not especially well built for heavy gains. This class of steers go into the feed-lot in fair condition. Those stockmen who put on the heavy gains take cattle with all the quality possible, and pay particular attention to the beef type conformation. High quality feeding cattle, with good conformation, are bought at a high price in any market, but when such stuff is finished with a gain of 400 to 500 pounds it very easily goes to the export trade, which will quite often pay for the extra care of selection, together with high-class feeding.

HEAVY CATTLE.

The heavier cattle carry a higher degree of ripeness, and therefore have reached more nearly the best finish which is possible to give them. Some of these heavyweight cattle were receiving two or three pounds of cottonseed meal at the last to put on the finishing touches. The muscular fiber of the heavyweight steers is better developed; the feeding has been on a narrower ration and the quality of the meat

produced draws buyers, with good prices, whereas the animals with light gains have not the same quality of meat, and therefore command lower prices.

The light gains and little finish are usually made when there is a rush to reach a rising market. Unfinished cattle are found in the stockyards partly because men are so eager to make, and fearful of losing, and partly because the stockman or feeder has not been skilled in the choice of foodstuffs which will give the desirable finish to suit the highest class trade.

THE WOLFF-LEHMAN FEEDING STANDARDS.

Annual.	Per Day per 1000 Pounds Live Weight. Digestible Nutrients.					
	Dry Matter.	Protein	Carbo-Hydrates.	Fat.	Total.	Nutritive Ratio.
Growing Cattle.	lbs.	lbs.	lbs.	lbs.	lbs.	lbs.
2 to 3 mo. weighing about 160 lbs..........	23	4.2	13.0	2.0	19.2	1:4.17
3 to 6 mo. weighing about 330 lbs......................	24	3.5	12.8	1.5	17.8	1:4.62
6 to 12 mo. weighing about 350 lbs......................	25	2.5	13.2	0.7	16.4	1:5.91
12 to 18 mo. weighing about 750 lbs......................	24	2.0	12.5	0.5	15.0	1:6.81
18 to 24 mo. weighing about 950 lbs......................	24	1.8	12.0	0.4	14.2	1:7.17
Fattening Cattle.						
First Period..................	30	2.5	15.0	0.5	18.0	1:6.45
Second Period	30	3.0	14.5	0.7	18.2	1:5.36
Third Period..................	26	2.7	15.0	0.7	18.4	1:6.14

The table gives a list of the most common feeding stuffs for fattening cattle in the State of Maryland. The computations are based upon the table of "Average Digestible Nutrients in American Feeding Stuffs," given in Prof. W. A. Henry's book, "Feeds and Feeding." The aim has been to facilitate the computation of rations, and to present figures in such simple form that no feeder will have difficulty in making up a ration according to the standards given from the material he has available on his farm.

Column one is headed "dry matter," and there is the digestible nutrients, which are divided into four separate columns. The first is "protein," second "carbohydrates," third "fats" and fourth the total. The last column gives the nutritive ratio.* In each of the columns is given the computations of the various food stuffs from one pound up to the amount that is likely to be used in compunding a ration.

*The proportion of digestibie nitrogenous food (protein) to the non nitrogenous (carbohydrates plus fat).

Kind and Amount of Feed.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
Red Clover Hay, 1 lb.	.847	.068	.358	.017	.443	1:5.8
“ “ “ 3 “	2.541	.204	1.074	.051	1.329	
“ “ “ 5 “	4.235	.034	1.790	.85	2.215	
“ “ “ 8 “	6.776	.544	2.864	.136	3.544	
“ “ “ 9 “	7.623	.612	3.222	.153	3 987	
“ “ “ 12 “	10.164	.816	4.296	.204	5.316	
“ “ “ 15 “	12.705	1.020	5.370	.255	6 675	
“ “ “ 18 “	15 246	1.228	6.444	.306	7.974	
“ “ “ 20 “	16.940	1.360	7.160	.340	8.860	
Alfaffa Hay.....1 lb.	.916	.11	.396	.012	.518	1:3.8
“ “ .....3 “	2.748	.33	1.188	.036	1 554	
“ “ .....5 “	4.580	.55	1.980	.060	2 590	
“ “ .....8 “	7.328	.88	3.168	.096	4.144	
“ “ .....9 “	8.244	.99	3.564	.108	4 662	
“ “ ....12 “	10 992	1.32	4.752	.144	6.216	
“ “ ....15 “	13 740	1.65	5.940	.180	7.770	
“ “ ....18 “	16.488	1.98	7.128	.216	9.324	
“ “ ....20 “	18.320	2.20	7.920	.240	10.360	
Corn Fodder.....1 lb.	.578	.025	.346	.012	.383	1:149
“ “ .....3 “	1.734	.075	1.038	.036	1.149	
“ “ .....5 “	2.890	.125	1 730	.060	1.915	
“ “ .....8 “	4 624	.200	2.768	.096	3.064	
“ “ .....9 “	5 202	.225	3.114	.108	3.447	
“ “ ....12 “	6.936	.300	4.152	.144	4.596	
“ “ ....15 “	8.670	.375	5.190	.180	6.894	
“ “ ....18 “	10.404	.450	6.228	.216	6.894	
“ “ ....20 “	11.560	.500	6.920	.240	7.660	
Corn Silage.....1 lb.	.21	.009	.113	.007	.129	1:14
“ “ .....5 “	1.05	.045	.565	.035	.645	
“ “ ....15 “	3 15	.135	1 695	.105	1.935	
“ “ ....20 “	4.20	.180	2.180	.140	2.580	
“ “ ....25 “	5 25	.225	2.825	.175	3.225	
“ “ ....30 “	6 30	.270	3 390	.210	3.870	
“ “ ....35 “	7.35	.315	3 955	.245	4.615	
“ “ ....40 “	8 40	.360	6.360	.280	3.160	
Corn Stover.....1 lb.	.60	.017	.324	.007	.338	1:20
“ “ .....5 “	3.00	.085	1 620	.035	1 690	
“ “ .....8 “	4.80	.136	2.592	.056	2 704	
“ “ ....12 “	7 20	.204	3.888	.084	4.056	
“ “ ....15 “	9.00	.255	4 860	.105	5.070	
“ “ ....18 “	10.80	.306	5.832	.126	6.084	
“ “ ....20 “	12.00	.340	6.480	.140	7.760	
Corn (Av.)......1 lb.	.89	.079	.667	.043	.789	1:9.7
“ “ ......2 “	1.78	.158	1.334	.086	1.578	
“ “ ......3 “	2.67	.237	2.001	.129	2.367	
“ “ ......4 “	2.67	.316	2.668	.172	3.156	
“ “ ......5 “	4.45	.399	3.335	.215	3.945	
“ “ ......6 “	5.34	.477	4.002	.258	4.734	
“ “ ......7 “	6.23	.553	4.669	.301	5.522	
“ “ ......8 “	7.12	.612	5.336	.344	6.312	
“ “ ......9 “	9.01	.711	6.003	.387	7.101	
Corn and Cob Meal 1 lb	.849	.044	.60	.029	.673	1:15.2
“ “ “ 2 “	1.698	.088	1.20	.058	1.346	
“ “ “ 3 “	2.547	.176	1.80	.087	2.019	

Kind and Amount of Feed.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
Corn and Cob Meal 4 lb	3.396	.176	2.40	.116	2.692	
" " " 5 "	4.245	.220	3.00	.145	3.365	
" " " 6 "	5.094	.264	3.60	.174	4.058	
" " " 7 "	5.943	.308	4.20	.203	4.711	
" " " 8 "	6.792	.352	4.80	.232	5.384	
" " " 9 "	7.641	.396	5.40	.261	6.057	
Barley ....1 lb.	.891	.087	.656	.016	.759	1:7.8
" ....2 "	1.782	.174	1.312	.032	1.518	
" ....3 "	2.673	.261	1.968	.048	2.277	
" ....4 "	3.567	.348	2.624	.064	3.036	
" ....5 "	4.455	.435	3.280	.080	3.795	
" ....6 "	5.346	.522	3.936	.096	4.554	
" ....7 "	6.237	.609	4.592	.112	5.313	
" ....8 "	7.128	.696	5.248	.128	6.072	
" ....9 "	8.019	.783	5.904	.144	6.813	
Oats ....1 lb.	.89	.092	.473	.042	.607	1:6.2
" ....2 "	1.78	.184	.946	.084	1.214	
" ....3 "	2.67	.276	1.419	.126	1.821	
" ....4 "	3.56	.368	1.892	.168	2.428	
" ....5 "	4.45	.460	2.365	.210	3.035	
" .... 6 "	5.34	.562	2.838	.252	3.642	
" ....7 "	6.23	.654	3.311	.294	4.249	
" ....8 "	7.12	.746	3.784	.336	4.856	
" ....9 "	8.01	.838	4.257	.378	5.463	
Wheat Bran.....1 lb.	.88	.12	.39	.027	.537	1:3.7
" " ....2 "	1.76	.24	.78	.054	1.074	
" " ....3 "	2.64	.36	1.17	.081	1.611	
" " ....4 "	3.52	.48	1.56	.108	2.148	
" " ....5 "	4.40	.60	1.95	.137	2.685	
" " ....6 "	5.28	.72	2.34	.162	2.222	
" " ....7 "	6.16	.84	2.73	.189	3.759	
" " ....8 "	7.04	.96	3.12	.216	4.296	
" " ....9 "	7.92	.108	3.51	.243	4.833	
Brewers Gr., dry 1 lb.	.918	.157	.363	.051	.571	1:3
" " " 2 "	1.836	.314	.726	.102	1.142	
" " " 3 "	2.754	.471	1.089	.153	1.713	
" " " 4 "	3.672	.628	1.452	.204	2.284	
" " " 5 "	4.590	.785	1.815	.255	2.855	
" " " 6 "	5.508	.942	2.178	.306	3.426	
" " " 7 "	6.426	1.099	2.541	.357	3.997	
" " " 8 "	7.344	1.256	3.904	.408	4.568	
" " " 9 "	8.262	1.413	3.267	.459	5.139	
Gluten Meal.....1 lb.	.918	.258	.433	.11	.801	1:2.7
" " .....2 "	1.836	.516	.866	.22	1.602	
" " .....3 "	2.754	.774	1.299	.33	2.403	
" " .....4 "	3.672	1.032	1.732	.44	3.204	
" " .....5 "	4.590	1.290	2.165	.55	4.005	
" " .....6 "	5.508	1.548	2.598	.66	4.806	
" " .....7 "	6.426	1.806	3.031	.77	5.607	
" " .....8 "	7.344	2.064	3.464	.88	6.408	
" " .....9 "	8.262	2.322	4.697	.99	7.209	
Linseed Meal O.P.1 lb	.908	.293	.327	.007	.627	1:1.2
" " " 2 "	1.816	.586	.654	.014	1.254	
" " " 3 "	2.724	.879	.981	.021	1.881	

Kind and Amount of Feed.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
Linseed Meal O. P. 5 lb	4.540	1.465	1.634	.035	3.135	
" " " 6 "	5.448	1.758	1.962	.042	3.762	
" " " 7 "	6.356	2.051	2.289	.049	4.389	
" " " 8 "	7.264	2.344	2.616	.056	5.016	
" ", " 9 "	8.172	2.637	2.943	.063	5.643	
Cottonseed Meal 1 lb.	.918	.372	.169	.122	.663	1:1.24
" " 2 "	1.836	.744	.338	.244	1.326	
" " 3 "	2.754	1.116	.507	.488	1.989	
" " 4 "	3.672	1.488	.676	.610	1.652	
" " 5 "	4.590	1.860	.845	.732	2.315	
" " 6 "	5.508	2.232	1.014	.854	2.978	
" " 7 "	6.426	2.604	1.183	.976	3.641	
" " 8 "	7.344	2.976	1.352	1.098	4.304	
" " 9 "	8.262	2.348	1.521	1.120	4.967	
Hominy Chop....1 lb.	.889	.075	.552	.068	.695	1:9.5
" " ....2 "	1.778	.150	1.104	.136	1.390	
" " ....3 "	2.667	.225	1.656	.204	2.185	
" " ....4 "	3.556	.300	2.108	.272	2.880	
" " ....5 "	4.445	.375	2.660	.340	3.575	
" " ....6 "	5.334	.450	3.212	.408	4.270	
" " ....8 "	6.223	.525	3.764	.476	4.965	
" " ....9 "	7.112	.600	4.316	.544	5.650	
" " " 4 "	3.632	1.172	1.308	.028	2.508	

RATION COMPARED WITH STANDARD.

After studying the methods of handling cattle, as done by the most successful feeders, it will be interesting to note some of the daily rations given to animals which are not fattened on grass. The following rations are fairly representative of the prevailing methods of feeding throughout the State.

Farm No. 1—On this farm, located in Montgomery county, cattle weighing about 850 to 900 pounds are bought usually about the first of November. The first winter these cattle are kept over on long corn fodder, and sometimes a little corn meal. The following summer grass constitutes the feed until corn is ready to feed in the fall. They are then taken up and grained on a ration of ground corn and bran, and finished in time for the early winter market. The past winter a herd of grade Shorthorn steers, which averaged about 950 pounds, were receiving a daily ration of about 30 pounds of silage, a peck of corn meal and bran mixed in equal parts by measure, with what long corn stover they cared to eat. These cattle were being prepared for the June market. The amount of mixed grain was to be increased as feeding progressed. Calculating out the food constituents furnished by this ration we have the following results:

FARM NUMBER I.

Kind and Amount of Feed Used.	Dry Matter.	Digestible Nutrients. Protein.	Carbohydrates.	Fat.	Total.	Nutritive Ratio.
	lbs.	lbs.	lbs.	lbs.	lbs.	
Silage 30 lbs..................	6 30	.270	3.39	.210	3.870	
Corn Stover 10 lbs...........	6.00	.17	3.24	.07	7.76	
Corn 5 lbs.....................	4 45	.399	3.335	.215	3.945	
Bran 5 lbs.....................	4.40	.60	1.95	.137	2.685	
	21.15	2 5	11.915	.632	14.380	1:10
Standard Ration	30.00	2.5	14.5	.7	18.2	1:5.36

Comparing the above ration with the standard, it is found faulty in that it does not furnish enough protein, and hence the nutritive ratio is too wide. Now this deficiency could be remedied easily and cheaply by alfalfa hay. The alfalfa being narrow in nutritive ratio should replace the bran, and a part of the stover, which is coarser, less palatable and wider in nutritive ratio.

Farm No. 2—This farm in Harford county is located in the grass region, and on it two or more lots of cattle are handled annually. The cattle which go through on grass are seldom given any grain before they go to market. The other lot is fattened the first winter on a ration consisting of 35 pounds of silage, 5 pounds of stover, 8 pounds of corn and cob meal and 2 pounds of cottonseed meal. The cattle

Kind and Amount of Food.	Dry Matter.	Digestible Nutrients. Protein.	Carbohydrates.	Fat.	Total.	Nutritive Ratio.
Silage 35 lbs.........	7.35	.315	3.955	.245	4.615	
Corn Stover 5 lbs....	3.00	.085	1.620	.0773	1.794	
Corn and Cob Meal 8 lbs	6.792	.352	4.80	.232	5.384	
Cottonseed Meal 2 lbs	1·836	.744	.338	.244	1.326	
	18.978	1.496	10.713	.672	14.805	1:9
Standard............	2.6	2.7	15.0	0.7	184.	1:6.14

receiving this ration, although they were to be sold in a few days, were looking rough, and did not show proper finish. A change of one pound of crushed corn for one of cottonseed meal would have been far better for the cattle. The nutritive ratio would be 1:69, instead of 1:9. Some clover hay in place of some of the corn stover would have been well, because the stover is coarse, and not so palatable. The nutritive ration of clover is 1:5.8, and corn stover is 1:20.

Farm No. 3—In the western part of Baltimore county there is a farm on which some two or three hundred head of cattle are fattened annually. Some are fattened on grass, with a little grain at times. The largest number, however, is finished in the lot on a ration of thirty pounds of silage, mixed hay mostly clover, eight pounds, and about ten pounds of grain, which consisted of three pounds bran and seven pounds corn and cob-meal.

Kind and Amount of Food.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Silage 35 lbs.................	7.35	.375	3.955	.245	4.615	
Mixed Hay 8 lbs.............	6.418	.444	3.054	.128	3.626	
Corn and Cob Meal 7 lbs......	5.943	.308	4.20	.203	4.711	
Bran 3 lbs....................	2.64	.36	1.17	.081	1.611	
Total.........................	22.351	1.487	12.379	.658	14.564	1:9.2
Standard......................	26.	2.7	15.	.7	18.4	1:6.14

All the feed stuff going into this ration, except the bran, was raised on the man's own farm. The cattle going off this farm seldom made heavy gains while feeding, because just as soon as the steer has smoothed over he was sent in to Baltimore as a handy weight butcher bullock. In this rapid forcing process of fattening to make the ration narrower would increase its cost. A change from seven pounds of corn and cob meal to five pounds of corn would narrow the ration, and be better, because there is already plenty of roughage furnished by the hay and silage.

Farm No. 4—Again, at a farm near Reisterstown, in the same county as farm No. 3, a ration consisting of silage, long fodder and cottonseed meal was used. By skilful management the steers were taught to eat a daily ration of 11 pounds of cottonseed meal, with 35 pounds of silage, and approximately 10 pounds of stover.

Kind and Amount of Food.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn Silage 35 lbs...	7.35	.315	3.955	.245	4.615	
Corn Stover 10 lbs ..	6.00	.17	6.48	.07	7.76	
Cottonseed Meal 11 lb	10.098	3.092	1.859	1.364	6.293	
Total.................	23.448	3.577	9.054	1.679	14.788	1:4.4
Standard............	26.	2.7	15.	.7	18.4	1:614

This ration contained more cottonseed meal than any other found among the feeders of beef animals, and moreover, it is too expensive when cottonseed is bringing $32 per ton on the market. A more liberal use of corn, which is the cheapest fattening food, should be used. Cattle with such a ration does not stand a long feeding period, but must be sold when finished, or, as reported, they take a set back, and cause a serious loss to the owner. Finally it may be said that variety which this ration lacks is very important, since it stimulates appetite, which a steer must have to make good gains.

Farm No. 5—This farm, located in Carroll county, is managed by a man who is said to be one of the most successful feeders of beef in Maryland. He feeds cattle only in the winter season, and makes them big and heavy, and weigh 1,400 to 1,500 pounds by the time they are ready to go to market. From his barns cattle go out well ripened and covered with a deep covering of thick flesh. Here cattle received much attention, many little kindnesses and a variety of appetizing foodstuffs. The ration consisted of good sweet clover hay, mixed with timothy, alfalfa, corn silage which would make fifteen barrels of corn to the acre, ground corn and some cottonseed meal. The alfalfa was never fed but once per day.

The ration which was finishing a bunch of cattle, which had made about 400 pounds gain at the rate of about two pounds per day, consisted of 20 pounds of silage, 5 pounds of alfalfa, approximately 9 pounds of mixed hay, and about 6 pounds of grain, which was 4 pounds of corn and 2 pounds of cottonseed meal.

Kind and Amount of Food.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Silage 20 lbs.	4.20	.18	2.18	.14	2.58	
Alfalfa 5 lbs.	4.58	.55	1.98	.06	2.59	
Mixed Hay 9 lbs.	7.707	.452	3.526	.141	4.119	
Corn 4 lbs.	3.56	.316	2.668	.112	3.156	
Cottonseed Meal 2 lbs	1.836	.744	.338	.244	1.326	
Total	21.883	2.242	10.592	.757	12.781	1:6
Standard Ration	26.	2.7	15.	.7	18.4	1:6.14

This is an excellent ration, properly balanced, and furnishing a variety which keeps up the appetite of the steer for heavy feeding. All the feed except the cottonseed meal is raised on the place. Straw was used for bedding, but a large share of the bedding was made by shredding the coarse corn stover.

A rotation of crops, a liberal application of barnyard manure, and the plowing under of green crops have made the farm highly productive.

Farm No. 6—Now, going west to Garrett county, the feeding practiced there will be fairly well represented by a farm near Grantsville. The roughage consists of mixed hay, timothy and clover and corn stover. The grain consisted of eight pounds crushed corn and two pounds of oats.

Kind and Amount of Food.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn Stover 15 lbs..	9.00	.255	4.86	.105	5.07	
Mixed Hay 6 lbs....	5.138	.301	2.35	.094	2.746	
Corn & Cob meal 8 lbs	6.792	.352	4.80	.232	5.384	
Oats 2 lbs...........	1.78	1.84	.946	.084	1.214	
Total................	22.710	1.092	13.056	.515	14.404	1:12
Standard Ration....	26.	2.7	15.	.7	18.4	1:6.14

This ration is faulty, because it is too wide, and does not contain enough grain. The animal has to make too much of his gains from rough feed, which he will not do. As would be expected, the cattle in this instance were not making rapid gains. True, all the feed was raised on the farm, but nevertheless some bran, cottonseed meal or gluten meal could probably have been used with advantage. Some silage would have made it more palatable, and stimulated the animal's appetite.

Farm No. 7—In Dorchester county, on a farm near the Atlantic Coast, cattle were getting as a finishing ration 15 pounds of silage, corn and cob-meal mixed with brewer's grains half and half, about eight pounds, corn stover ten pounds, mixed hay four pounds, and cottonseed meal three pounds.

Kind and Amount of Food.	Dry Matter.	Digestible Nutrients.				Nutritive Ratio.
		Protein.	Carbohydrates.	Fat.	Total.	
	lbs.	lbs.	lbs.	lbs.	lbs.	
Corn Silage 15 lbs...	4.20	.180	2.18	.14	2.58	
Corn Stover 10 lbs...	6.00	.17	3.24	.07	3.38	
Mixed Hay 4 lbs.....	3.424	.20	1.564	.062	1.83	
Corn &Cob Meal 4 lbs.	6.00	.17	3.24	.07	3.38	
Brewers DryGr.4 lbs.	5.138	.301	2.35	.094	2.746	
CottonseedMeal 2 lbs.	1.836	.744	3.38	.244	1.326	
Total................	26.598	1.765	12.912	.680	15.242	1:8.2
Standard Ration.....	26.	2.7	15.	0.7	18.4	1:6.14

This ration has the required amount of dry matter, but a little too wide in nutritive ratio. The amount of fats and carbohydrates will do fairly well, but the protein is too low. A little more cottonseed meal could replace the cob in the cob-meal probably to good advantage.

The amount of grain going into the rations on the several farms above mentioned was very easily obtained, but the roughage was not weighed, and could only be estimated or approximated from the total fed out for a number of days.

Farm No. 8—On this farm, located in Talbot county, cattle had been fed for a great many years. In fact, a fully-detailed account of the work had been kept recorded very systematically in a note-book. From the book I quote the following data:

After getting the 20 head of cattle started, they were from December 12 given a ration consisting of twenty pounds of silage, three pounds of fodder, three pounds of oats, ten pounds of corn-meal, two pounds of middlings and one pound of cottonseed meal. Nothing was noted about what tables were used to derive the following figures:

FEED.	Dry Matter.	Protein.	Carbohydrates.	Fat.
Corn Silage 20 lbs	3.90	0.24	2.36	.12
Corn Fodder 3 lbs	1.65	.08	.88	.03
Crushed Oats 3 lbs	2 27	.04	1 25	.02
Corn Meal 10 lbs	8.73	.71	6.30	.39
Middlings 2 lbs	1.69	.24	.94	.05
Cottonseed Meal 2 lbs	.85	.36	.18	.12
Total	19.09	1.67	12.01	.73
Standard Ration	25.	2.07	14.8	.6

On December 19 the cattle were weighed, and the following table was made out, which gives results in good tabular form for reference:

CATTLE.	Dec. 19, weight	Dec. 12, weight.	Av. wt. of Steer.	Gain per head.	Av. rate per day.
	lbs.	lbs.	lbs.	lbs.	lbs.
5 Steers	6270	6150	1254	x24	3 42
5 "	6770	6670	1354	x20	2.85
5 "	5850	5730	1170	x24	3.42
5 "	6050	5900	1210	x30	4.28
Total Average	24940	24450	1247	x25	3.57

The cattle were weighed every week, and the above ration, although not up to the standard, was fed until the average gain per day

showed a decline. On January 2 the cattle had been at feed for 42 days, and had gained 102 pounds, at the rate of 2.5 pounds per day. January 9 they had made a total gain per head of 132 pounds.

A change was made in the ration on January 30, and the following was given:

AMOUNT OF FEED GIVEN.	Dry Matter.	Protein.	Carbohydrates.	Fat.	Nutritive Ratio.
Corn Silage 20 lbs............	4.18	.18	2.26	.14	
Corn Fodder 3 lbs............	1.78	.51	.97	.02	
Oats Straw 2 lbs.	1.81	.02	.77	.01	
Oats in Straw lb.............	.89	.09	.47	.04	
Corn Meal 11.53 lbs..........	10.22	.92	7.63	.49	
Middlings 2.31 lbs............	2.03	.29	1.22	.07	
Cottonseed Meal 1.16 lb......	1.06	.43	.19	.14	
Total.........................	21.97	2.44	13.51	.91	1:64
Standard Ration..............	25.	2.07	14.8	.6	1:6

On February 20 the cattle were weighed up, and it was found that the average gain was 255 pounds, at the rate of 2.8 pounds for the 91 days' feeding. But at the end of the next week the weighing showed a loss instead of a gain, because the cattle had suffered in a severe snowstorm.

The daily ration was again changed on March 21 to 10 pounds of silage, six pounds of hay, two pounds of oats hay, one pound of oats, 12.13 pounds corn-meal, 2.61 pounds middlings and 1.26 pounds of cottonseed meal. This ration furnished 24.23 pounds dry matter, 2.10 pounds protein, 14.74 pounds carbohydrates and 0.95 pounds fat.

The amount of silage was cut down because the manager sought to get the cattle in market condition for sale about April 10.

When data has been kept in so full a form, it makes the farm a veritable experiment station to the owner.

GROWING FEEDERS.

In no section is diversified farming followed so extensively as in the western counties of the State. In Garrett county beef production is carried on in connection with dairying. The kind of cattle which most of the farmers keep is grade Shorthorns. The cows are used in the farm dairy, while the steers are sold as stock cattle, or are fed out and sold to the butchers who supply the nearby coal-mining towns with meat. A few stock cattle are raised in the western part of Washington county. These are quickly gathered up by stockmen, and seldom do any of them get very far before they are put into feed lots and finished for the local, and sometimes Baltimore butcher trade. Why more cattle are not raised on these mountain pastures is not easily understood. The chief trouble seems to lie in the fact that sufficient forage is not raised to maintain the cattle and breeding stock during the winter season.

PURE BRED HERDS OF BEEF CATTLE.

The number of pure bred herds of beef cattle in Maryland, though small, yet is sufficient to supply the demand for breeding stock. They are distributed over the different parts of the State, and consist of Shorthorns, Herefords and Aberdeen Angus. Some of the stock have been to several of the leading fairs, and returned home with the first prizes. Although good bulls are produced, the dairy interests are holding their sale in check.

BEEF PRODUCTION AND DAIRYING.

When considering the price which some farmers are getting for their milk, and the extra labor which must be employed, the net returns would be greater and easier obtained, if stock feeding and the raising of feeders was given more attention. Some fine feeding cattle have been produced in the western part of Washington county by the use of a good beef sire on the semi-dairy cows. The grade Hereford herds in Talbot county have produced many fine animals, which have been finished at an early age, and made into toppers at the Philadelphia market. From these herds the surplus stock has been finished and sold pretty much as baby beef, and when marketed early the heifers sold as well as the steers. There was no distinction made because of sex.

Dairying is no easy task, and requires considerable labor at best, and a great many boys on the farm have no taste for the work. Such boys seldom prove to be good dairy farmers, and they would probably find beef-stock raising and fattening to be more congenial and, under present conditions, as profitable.

MARKETS FOR BEEF.

Maryland has four large markets to which fattened cattle are taken for sale, namely, Pittsburg, Washington, Baltimore and Philadelphia. From sale reports Philadelphia has proven the most favorable. In addition to these markets very many animals are in active demand by local butchers. In Garrett and Allegheny counties, especially about the mining towns, there is a strong demand for all of the beef produced in the nearby districts.

Many ways of marketing cattle are available. Some are consigned to commission merchants; some sold directly to local and distant butchers, who visit herds and buy their own cattle, and some are sold to buyers and shippers. Some men of Cecil county sell their cattle to a butcher, who comes out to the farm and takes the animals, one or more, as soon as they are ready for the block. At one place the bullocks were slaughtered on the farm, and the owner paid from the dressed weight.

When consigning to commission merchants at a distant market the cattle have been sent by rail, or by water. Transportation from the farm to market has more or less unavoidable loss through driftage; but these losses have to be met by an increased price. Driftage can be reduced to a minimum by not feeding the animals too heavy on grain just previous to starting for market, and also by not permitting them to drink too much.

Cattle will go to market best on dry feed and little water. This is especially true when driven to market. Men driving in from Montgomery county to Washington have had light driftage until the cattle received water en route. Then, if watered before the cattle arrived at the yards, the loss was estimated to be two or three times greater.

PROFITS.

The amount of profit which a man is able to make is dependent upon the man and his ability to master the forces about him. In the cattle business one man does well by handling registered animals; another does better with grades, and still another will do best by feeding and fattening what his neighbor raises. When feeding cattle some men have made as much on stock at a six months' feed as others have made in a year's feeding. Such a result is not because of a reserve of capital, but because there had been more business sagacity and more skilful management of the stock and the food given. Profits on finished bullocks hav been ranging from 20 to 36 dollars per head. But some men, given away either to the fever of speculation, or to the fear of losing, have sold for far less profit.

The margin of profit on which cattle are to be fed is getting quite small. The possibility of having an advance of $2.00 per hundred on the cost price is usually out of the question. The cost of producing the animal for the feed lot has increased, and many other things, acting on the markets for beef, have had an influence on the chance for large profits, so that now the smaller margin of $1.00 to $1.50 does not allow much more than selling prices for feed. At a few farms, cattle were being fed under contract with the commission men for only $1.00 advance on the hundred (under this contract the cattle were to be delivered at a certain date). But experience has shown men that a margin less than $1.00 on the hundred is very doubtful business, and seldom attended with success.

One dollar per hundred advance usually just about pays for the feed, and leaves the manure for the labor and profit.

To illustrate the point of margin in cattle feeding, the following example will be given:

A stockman buys a 900-pound steer at $3.85 per hundred, paying $34.65 for him; he sells him at $5.00 per hundred, after he has made 300 pounds gain, and at the sale receives $60. Now the margin or advance in this instance is the difference between $3.85 and $5.00, or $1.15.

Here a question naturally arises: How much profit can be figured from the above transaction? Not less than $8.00 per hundred should be allowed to cover the cost of feed, and of the labor to care for the cattle.

The first cost of animal is 900 pound at $3.85 (100)......$34.65
Cost of gains, 300 pound at $8.00 (100)................. 24.00

Total cost $58.65
Selling price and total return, 1200 pounds at $5 per 100...$60.00
Net profit, $60.00 minus $58.65....$1.35.

The gross returns are $60.00 minus $34.65 equals $25.35.

Then, again, the interest on $60 at six per cent. is $3.60 per year, and for four months, the length of the feeding period, $1.20; therefore $1.35 profit allows more than six per cent. on the investment.

The above figures are taken from average weights, prices paid out and received for stock, and will represent average conditions fairly well.

FEED REQUIRED TO GROW STEERS.

By H. J. Patterson.

Information is frequently requested as to the amount of food required to grow a steer. In order to make this information more generally available, the records in Tables 1 to 6 are appended to this bulletin.

TABLE I.

Record of Feed Consumed and Gains made by Steers Nos. 73 and 74. Aberdeen Angus Calves entitled to Registry.
(Weaned at 5 days old.)

Mo.	Date 1905	Steer † 73 (Dropped Feb. 23) Milk	Grain	Hay	Wt.	Gain	Steer 74 † (Dropped Feb. 28) Milk	Grain	Hay	Wt.	Gain
1	March	224	10	......	105	......	184	6	......	97	......
2	April	240	50	......	144	39	240	50	......	140	43
3	May	366	69	18	194	50	366	69	18	185	45
4	June	538	71	50	225	31	540	67	50	226	41
5	July	558	74	90	273	48	558	74	90	277	51
6	Aug.	Pasture.	48	......	299	26	Pasture.	50	......	315	38
7	Sept.	"	31	......	327	28	"	31	......	363	48
8	Oct.	"	74	......	332	5	"	77	......	381	18
9	Nov.	"	174	140	369	37	"	174	140	409	28
10	Dec.	"	225	180	420	33	"	225	181	468	59
	1906										
11	Jan.	"	244	186	475	55	"	214	186	490	22
12	Feb.	"	224	215	552	77	"	202	215	552	62
13	Mar.	"	240	275	615	63	"	236	275	617	65
14	April	"	300	240	653	38	"	295	239	680	63
15	May	"	324	200	693	40	"	310	215	731	51
16	June	"	324	230x	735	42	"	308	230	791	60
17	July	"	335	230	781	46	"	335	230	827	36
18	Aug.	"	253	334	772	9	"	246	276	830	3
19	Sept.	"	330	300	815	43	"	330	300	913	83
20	Oct.	"	341	310	858	43	"	341	310	953	40
21	Dec.	"	300	250	852	6	"	300	250	967	14
22	Dec.	"	324	228*	862	10	"	314	257	994	27
	1907										
23	Jan.	"	310	225*	917	55	"	310	255	1053	59
24	Feb.	"	280	340x	963	46	"	280	345	1087	34
	Mar.	"	150	168	986	23	"	150	194	1111	24
	Total	1926	5135	4209		881	1888	4994	4255		1014

Steer † 73
Gained 1.18 lbs. per day for 745 days.
Required for each pound of gain.
5.83 lbs. of grain.
4.78 " " hay.
2.18 " " milk.

Steer † 74
Gained 1.36 lbs. per day.
Required for each pound of gain.
4.92 " " grain.
4.19 " " hay.
1.08 lbs. of milk.

x Crimson clover hay. * Corn fodder.

TABLE II.

Record of Feed Consumed and Gains made by Steer 76.
(Sire Aberdeen Angus. Dam Shorthorn.)
Weaned March 1, 1906. 4½ months old, Weighed 330 lbs.

1906.	STEER 76 (dropped October 12, 1905).			
	Grain.	Hay.	Weight.	Gain.
March 15			330	
March 30	70	30	343	13
1 April	177	120	391	48
2 May	225	110	451	60
3 June	236	160x	507	56
4 July	244	120	558	51
5 August	184	285	574	16
6 September	270	300	655	81
7 October	279	310	712	57
8 November	300	250	740	28
9 December	314	225	757	17
10 January	310	202	820	63
11 February	280	285	868	48
12 March	150	133	890	22
Total	3039	2530		560

Average gain per day 1.53 lbs. Food consumed for each pound of gain.
5.43 lbs. of grain.
x—Crimson clover hay. 4.52 " of hay.

TABLE III.

Record of Feed Consumed and Gains made by Steer No. 77.
(Sire Aberdeen Angus, Dame Shorthorn).
Weaned at 6 days old.

Mo.	Date.	STEER NO. 77, DROPPED AUGUST 25, 1905.				
		Milk.	Grain.	Hay.	Weight.	Gain.
	September 1				79	
1	September 30	230	4		82	3
2	October	60	25	20	94	12
3	November	120	60	60	123	29
4	December	186	58	45	164	41
5	January		62	65	204	60
6	February		112	84	255	51
7	March		125	125	328	73
8	April		210	150	384	56
9	May		259	115	420	36
10	June		240	160	492	72
	Total	596	1155	824		413

July 5th Killed. Dressed 259 lbs. or 52.6%. Average gain per day 1.33 lbs.
Food consumed for each pound of gain.
Milk 1.44 lbs. Grain 2.8 lbs. Hay 2.0 lbs.

TABLE IV.

Food Consumed by Steers During their First Year.

Steer.	Total for 12 months.			For each pound of gain.			Gain.
	Milk.	Grain.	Hay.	Milk.	Grain.	Hay.	
73	1926	1294	879	4.3	2.9	2.0	447
74	1888	1239	879	4.1	2.7	1.9	455
76	....	1685	1335	....	4.1	3.5	382
77	596	1155	824	1.4	2.8	2.0	413
Average.				3.3	3.1	2.3	424

TABLE V.

Food Consumed by Steers During their Second Year.

Steer.	Total for 12 months.		For each pound of gain.		Gain.
	Grain.	Hay.	Grain.	Hay.	
73	3841	3330	8.8	7.6	434
74	3755	3376	6.7	6.0	559

The tables in the main explain themselves, but it is worthy of special note that it requires from two to three times as much feed to produce a pound of gain during the steers' second as their first year. These figures also show quite conclusively that steers to be profitably grown must be made to gather their own food as much as possible, and thus reduce labor expense to a minimum, and that at best they must be used as a means for converting unmarketable products into a marketable form. All of these records were for calves from the same Aberdeen Angus bull.

RATIONS FED.

The steers received, except for one or two months, when noted in Tables 1 and 2, a good quality of mixed timothy and clover hay as roughage. They were fed all of the hay they could eat at all times.

The grain rations were varied from time to time, according to what was available, and also in order to give a variety. They were made up as follows:

For Steers Nos. 73-74.

First and Second Months—Wheat bran and malt sprouts in equal parts, and Blachford's Calf Meal in the milk.

Third Month—Wheat bran, wheat middlings and malt sprouts mixed in equal parts.

Fourth Month—Malt sprouts and Blachford's Calf Meal mixed in equal parts.

Fifth and Sixth Months—Wheat bran, malt sprouts and Blachford's Calf Meal mixed in equal parts.

Seventh and Ninth Months—Wheat bran and gluten feed mixed in equal parts. This, with the hay, gave a nutritive ratio of 1:4.7.

Tenth and Eleventh Months—Wheat bran, hominy chop and gluten feed, mixed in equal parts. This, with the hay, gave a nutritive ratio of 1:5.5.

Twelfth to Eighteenth Month—Hominy chop, six parts; cottonseed meal, three parts; gluten feed, one part. This, with the hay, gave a nutritive ratio of 1:5.

Nineteenth Month—Hominy chop, six parts; cottonseed meal, three parts; wheat bran, one part.

Twentieth Month—Corn meal, two parts; cottonseed meal, two parts; wheat bran, one part; sucrene, two parts.

Twenty-first to Twenty-fifth Month—Sucrene alone (for description and analysis of same, see Bulletin 117). This, with the hay, gave a nutritive ratio of 1:5.0.

For Steer No. 76.

First to Sixth Month—Hominy chop, six parts; cottonseed meal, three parts, and gluten feed, one part. This, with the hay, gave a nutritive ratio of about 1:5.

Seventh Month—Corn meal, two parts; cottonseed meal, two parts; wheat bran, one part, and sucrene, two parts.

Eighth to Twelfth Months—Sucrene.

For Steer No. 77.

First Month—Wheat bran and Blachford's Calf Meal, mixed in equal parts.

Second to Fourth Month—Wheat bran and gluten feed in equal parts.

Fifth Month—Wheat bran, hominy chop, and gluten feed mixed in equal parts.

Sixth to Tenth Month—Hominy chop, six parts; cottonseed meal, three parts; gluten feed, one part.

STEER NO. 1.

	Milk	Grain	Hay	Weight	Gain
1901					
October	237	22	....	120	......
November	233	43	....	149	......
December	333	95	....	194	......
1902					
January	351	13	17	227	.....
February	306	138	23	282	......
March	332	191	24	317	......
April	384	203	40	408	288
Total	2187	705	104	....	......
May 1st to November 1st	......	462	Pasture.	528	120
to November 1st, 1903	Grain	Silage	and Hay	1001	473

HEIFER NO. 2.

	Milk	Grain	Hay	Weight	Gain
1901					
October	237	22	....	126	......
November	233	43	....	142	......
December	338	75	....	208	......
1902					
January	357	55	17	273	......
February	314	126	21	345	......
March	334	177	31	304	......
	338	210	66	484	358
Total					
April	2201	708	135	....	......
May 1st to November 1st	......	462	Pasture	471	13
to November 1st, 1903	......	....	....	785	314

STEER NO. 3.

	Milk.	Grain.	Hay.	Weight.	Gain.
1901					
October	237	22	....	122	......
November	233	43	....	146	......
December	334	95	....	185	......
1902.			....		......
January	351	13	17	226	......
February	306	138	23	260	......
March	332	191	24	292	......
April	384	203	40	359	237
Total	2177	710	104	....	......
May 1st to November 1st	......	462	Pasture.	597	238
to November 1st, 1903	......	....	....	1005	480

Date	Heifer No. 4.				
	Milk	Grain	Hay	Weight	Gain
1901					
October	152	15	....	94	......
November	233	43	....	119	......
December	338	75	....	168	......
1902					
January	357	55	17	217	......
February	307	126	21	277	......
March	334	177	31	337	......
April	388	210	66	408	314
Total	2109	701	135	....	......
May to November	Fed	Grain	Hay	633	225
to November 1st, 1903	......	....	....	....	......
Grain, Silage and Hay	......	....	....	453	320

Date	Steer No. 8				
	Milk	Grain	Hay	Weight	Gain
1901					
October	......	....	....	....	......
November	......	....	....	....	......
December	......	....	....	93	......
1902					
January	357	55	17	130	....
February	313	126	21	183	......
March	334	177	31	230	......
April	388	210	66	307	214
Total	1392	568	135	....	......
May to November	Fed	Grain	and Hay	....	......
to November 1st, 1903	......	....	....	522	215
Grain, Silage and Hay	......	....	....	862	340

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STABLE MANURES.

By W. T. L. Taliaferro* and H. J. Patterson.

PREFACE.

The experiments reported upon in this bulletin were planned by and conducted under the general supervision of W. T. L. Taliaferro, who was Agronomist of the Experiment Station from 1900 to 1906. The preparation of the matter for publication, and the discussion of the results, has been done by H. J. Patterson, with the assistance of Prof. Taliaferro, who has reviewed and revised the same.

EXPERIMENTS CONDUCTED.

The experiments were conducted on two series of plots. One covered a period of three years, and was located in Field No. 13, on the north side of the farm, just west of and adjoining the B. & W. pike. The other covered a period of seven years, and was in Field No. 38, located south of the Experiment Station buildings, and east of and adjoining the pike.

The manure was applied to the first corn crop, and only once during each four-year rotation, at the rate of ten tons per acre, and was as nearly uniform as it was possible to have it. The manure was mixed horse and cow manure, and represented fairly well the grade available on many Maryland farms.

The following is a list of the experiments conducted and the questions which it was aimed to get some definite information concerning:

1. Comparison of applications of fresh and rotted manure.
2. Time of application of manure—
   (a) Fresh vs. Rotted.
3. Plowing under vs. top dressing of manure.
4. Plowing manure under in the fall vs. spring.
5. Plowing manure under different depths.

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*Resigned the position of Agronomist of the Experiment Station in order to devote all his time to College work.

6. Subsoil plowing in conjunction with the use of manure.
7. Manure alone vs. manure and commercial fertilizer.
8. Comparison of manure and straw.
9. Effect of fresh vs. rotted manure on crimson clover.
10. Effects of manure on the stand of corn.

The general treatment of the plots was uniform. The crop rotation was as follows:

First Year—Corn (planted on sod land); Crimson clover seeded at last working of corn.

Second Year—Crimson clover turned under for corn (wheat seeded in corn stubble).

Third Year—Wheat (timothy and clover seeded in wheat).

Fourth Year—Timothy and clover hay.

The results given in the tables in the following pages represent the average yields obtained from four crops of corn and two crops of wheat, thus passing through the rotation twice. The yields of hay were lost so cannot be given in the tables.

(1) COMPARISON OF FRESH AND ROTTED MANURE.

The applications of fresh manure were made by taking it directly from the stable, and spreading it on the land, at the rate of ten tons per acre, applied with a manure spreader.

In the rotted manure series, plots 2 and 4, of Field 38, received well-rotted manure at the rate of 10 tons per acre, taken at each application from a large heap of that material.

For each of the other rotted manure plots a ton of fresh manure was hauled out and heaped near the plot in sufficient time before spreading to allow it to decompose into a condition which would be generally recognized as well-rotted manure.

The results given in the following table are the average of twelve one-tenth acre plots. Fresh manure was applied to six plots, and rotten manure to six plots, the plots alternated.

TABLE I.

Comparison of Yields from applications of Fresh and Rotted Manure on Field No. 38.

(yields per acre in bushels)

	* Corn Bushels.	† Wheat Bushels.
Unmanured (average of plots 5, 10, 15, 20,)	38 1	16.1
Fresh Manure (average of plots 1, 3, 7, 9, 13, 16,) .	70 7	19.7
Rotted Manure (average of plots 2, 4, 8, 11, 14, 17,).	65.1	19 1
Gain from fresh manure..........................	32.6	3 6
Gain from rotted manure..................	27.6	3.0
Gain of fresh over rotted manure......................	5.0	0 6

* Average of 4 crops. † Average of 2 crops

The yields of fodder and straw were in favor of the fresh manure, and were in about the same proportions as given for the grains. The observations on the growth of grass showed decidedly in favor of the fresh manure, and were even more marked than with the other crops.

Since well-handled manure in decomposition loses a portion of all its constituents, but relatively more of woody matter than of nitrogen and mineral elements, rotted manure is relatively richer than fresh manure. Plots 2 and 4, of Field 38, therefore received rather more actual plant foods than any of the other plots. They received practically the same amount of humus-making material as the fresh manure plots, and rather more than the other rotted manure plots, whose quotas of manure had lost something during decomposition beyond the limits of the respective plots.

Table 3 shows the yields of plots 2 and 4, compared with the yields of the adjacent plots of 1 and 2, which received the same treatment otherwise than the kind of manure.

Table 4 shows the yields of the other rotted and fresh manure plots in Field 38.

TABLE II.

Comparison of Yields from Application of Equal Quantities of Fresh and Rotted Manure.

	Corn* Bushels.	Wheat† Bushels.
Fresh Manure (average of plots 1 and 3)	82.8	19.9
Rotted Manure (average of plots 2 and 4)	71.6	22.9
Gain from Fresh Manure over Rotted	11.2	—3.0

* Average of 4 crops. † Average of 2 crops.

TABLE III.

Comparison of Yields from Application of Equal Quantities of Manure Applied.

Fresh from the Stable. Rotted in a heap before application.

	Corn* Bushels.	Wheat† Bushels.
Fresh Manure (average of plots 7, 9, 13, 16,	64.9	18.5
Rotted Manure (average of plots 8, 11, 14, 17,	61.8	17.2
Gain from Fresh Manure over Rotted	3.1	1.3

* Average of 4 crops. † Average of 2 crops.

Before discussing Tables 3 and 4, it may be stated that Field 38 was selected for this experiment because of its apparent uniformity, but it soon became evident that it decreased in fertility quite regularly from north to south, the direction in which the plots were numbered. As the fresh and rotted manure plots were alternated, and every fifth plot was left unmanured as a check plot, this difference in fertility did not interfere with the general result of the experiment, but gave additional interest in the comparison of the use of manure on soils of different degrees of fertility.

In general texture, as determined by borings, the soil throughout was quite homogeneous.

The results shown in Table 4 do not differ materially from those shown in Table 1, the fresh manure showing a slight gain over the rotted in both wheat and corn. From Table 3, however, it appears that the fresh manure gave the better yields with corn, and the rotted manure with wheat. This may be to some extent accounted for in the grosser feeding habit of corn, which enabled it to utilize the fresh manure to better advantage than the wheat, and in the fact that plots 2 and 4 received a slightly greater amount of actual plant food.

TABLE IV.

Comparison of Yields from application of Fresh and Rotted Manure on Field No. 13.

(yields per acre)

	Corn *		Wheat †	
	Grain.	Fodder.	Grain.	Straw.
Unmanured (plot 18)	75.1	6150	19.3	890
Fresh Manure (average of plots 19, 21)	92.6	7225	21.3	1120
Rotted Manure (average of plots 17, 20)	82.4	6500	20.3	860
Gain from fresh manure	17.5	1075	2.0	230
Gain from rotted manure	7.3	350	1.0	—30
Gain of fresh over rotted manure	10.2	725	1.0	260

* Average of two crops. † One crop.

The results obtained in both of these tests show clearly in favor of the use of fresh manure applied directly from the stable. When it is remembered that the use of the manure in this way would do away with at least one handling of it, the relative profits are greater than are represented by the increased yields.

The effects of the manures on the wheat crops are not so marked as with the corn, but this would naturally be expected, as two crops of corn had access to the manure before the wheat, and the remaining manure was thoroughly decomposed.

(2) WHEN SHALL MANURE BE APPLIED?

In connection with the use of manure, the question is frequently raised as to the best time of the year to apply it. This is particularly the case when discussing the question of applying the manure directly from the stables. With an idea of getting some data on this point, applications were made at four different periods. The applications were made on sod land before plowing, and previous to planting the land to corn.

The results are given in the following table:

TABLE V.

Results of applying Manure at different Seasons.

(Experiments conducted in Field 38. Yields per Acre.)

	Fresh Manure.		Rotten Manure.	
	Corn* Bushels.	Wheat † Bushels.	Corn* Bushels.	Wheat † Bushels.
Summer (July 26)	82.8	20.0	71.6	22.0
Fall (November 27)	69.1	18.4	68.0	17.3
Winter (January 12)	58.2	17.9	....	....
Spring (March 15)	57.5	17.8	61.4	18.0

* Average of 4 crops. † Average of 2 crops.

The results as given in the above table show clearly in favor of getting the manure on the land as long in advance of the time the crop is to use it as possible. The results as a whole are in favor of the use of fresh manure, but when the applications were made in the spring the rotted manure gave slightly better yields.

(3) COMPARISON OF APPLYING MANURE BEFORE AND AFTER PLOWING.

Plowing Under vs. Top Dressing.

The manner of applying manure should probably be varied with the character of the soil and the crop; yet usually the same results would be expected, on the average corn, wheat and grass soil, from a given practice.

TABLE VI.

Showing results of applying Fresh and Rotted Manure before and after Plowing.

(Experiments conducted in field 13. Yields per Acre.)

	Fresh Manure.				Rotted Manure.			
	Corn*		Wheat†		Corn*		Wheat†	
	Grain	Fodder.	Grain	Straw	Grain	Fodder.	Grain	Straw
	Bu.	Lbs.	Bu.	Lbs.	Bu.	Lbs.	Bu.	Lbs.
Before Plowing..........	87.2	6950	20.3	1080	82.3	6550	19.8	760
After Plowing...........	98.1	7500	22.3	1160	82.6	6450	20.7	960
Gain from using Manure as a Top-Dressing....	10.9	550	2.0	80	0.3	—100	0.9	200

* Average of 2 crops. † Average of 1 crop.

The above results are clearly in favor of applying the manure after plowing as a top dressing. They also show decidedly in favor of the use of fresh manure.

(4) COMPARISON OF PLOWING MANURE UNDER IN THE FALL AND SPRING.

The question arises in the minds of the farmer as to whether the loss in manure would not be prevented by plowing it down in the fall, instead of leaving it exposed on the surface all winter. In order to get some definite data on this point, the tests reported on in Table 5 were conducted. It must be remembered that the manure was applied but once in the rotation, and that to the first crop of corn, and that the effects on the wheat was only what remained after two crops of corn had already had access to the manure.

TABLE VII.

Showing yields of Corn and Wheat from Plowing Manure under in Fall and Spring.

(Tests conducted in field 38. Yields per acre.)

	Fall Plowing.		Spring Plowing.	
	Corn Bushels.	Wheat Bushels.	Corn Bushels.	Wheat Bushels.
Manure applied in the Summer........	75.9	20.9	78.4	21.1
Manure applied in the Fall............	62.2	17.4	69.9	18.3
Manure applied in the Spring..........	....	....	57.5	17.8

The results given in the above table are slightly, but uniformly, in favor of allowing the manure to remain on top of the land during the winter, and plowing it down in the spring, rather than plowing it down in the fall. This is probably due to the conditions near the surface being more favorable to nitrification, and consequently more of the manure has become available for crops.

Farmers sometimes object to the spreading of manure in summer, in the belief that when manure is so spread the hot summer suns burn out its substance, as they express it, and make it comparatively valueless. An inspection of Table 5 shows this belief to be unfounded. The manure spread in July gave better results than that spread in either Fall or Spring.

(5) COMPARISON OF PLOWING MANURE UNDER TO DIFFERENT DEPTHS.

In this experiment the manure was applied in the winter on sod land, and was plowed under at once. On one plot the land was plowed to the usual depth prevailing in that field, or seven inches deep, and the other plot was plowed but five inches deep. The effects of this treatment on the yields of corn and wheat are given in the following table:

TABLE VIII.

Showing the results of Plowing Manure under different depths upon yields of Corn and Wheat.

(Conducted on field 38. Yields per acre.)

	Corn* Bushels.	Wheat† Bushels.
Manure plowed under 7 inches	57.9	18.1
Manure plowed under 5 inches	56.5	14.7
Gain from deep plowing	1.4	3.4

* Average of 4 crops. † Average of 2 crops.

While these results do not show a very great difference, yet they are in favor of the deeper plowing, and as they were uniformly so from year to year with every crop, it may be safely concluded that it is usually best to plow deep, and that it is not harmful to plow the manure under deep. These results would seem to indicate that the contention of some farmers that manure should not be put in very deep is unwaranted, and that putting it in deep would probably stimulate the development of roots, and get additional advantages therefrom.

(6) SUB-SOIL PLOWING IN CONJUNCTION WITH MANURING.

The question as to the value of sub-soiling on stiff land is frequently asked, and this test was conducted in order to get some data on the subject.

The land was manured in the winter with fresh manure, and plowed in the spring. The ordinary plow turned the furrow to the depth of five inches, and the sub-soil plow followed in the same furrow, loosening the soil to the depth of five inches, but none of the sub-soil was brought to the surface.

The effects of this treatment on the yields of Corn and Wheat are given in the following table:

TABLE IX.

Showing results of Sub-Soil Plowing in connection with Manure.

(Conducted in field 38. Yields per acre.)

	Corn Bushels.	Wheat Bushels.
Fresh Manure and Sub-Soil Plowing................	50.9	12.5
Fresh Manure and Plowed under 7 inches..........	46.2	13.3
Gain from Sub-Soil Plowing.......................	4.7	....
Loss from Sub-Soil Plowing.......................	....	0.8

These results are not very decisive, as the corn crop shows slightly in favor of the use of the sub-soil plow, while the yield of wheat is slightly against it. At best it would appear that there was not sufficient advantage to warrant the extra expense involved.

(7) COMPARING THE USE OF MANURE ALONE WITH MANURE SUPPLEMENTED WITH COMMERCIAL FERTILIZERS.

It is commonly recognized that manure is relatively rich in nitrogenous plant food and deficient in potash and phosphoric acid. It is also frequently claimed that fresh manure is not quick enough in its action, and that it should be supplemented with some readily available plant food, such as is furnished by commercial fertilizers.

With the idea of testing some of these points in part, the tests reported upon in the following table were made:

TABLE X.

Showing the results of the use of Manure and Fertilizer in Combination.

	Field 38.		Field 13.	
	Corn Bushels.	Wheat Bushels.	Corn Bushels.	Wheat Bushels.
26. Unmanured	33.3	13.6	75.1	19.3
27. Manure alone	46.2	13.3	....	....
28. Manure and 300 pounds complete Fertilizer, broadcast	53.3	14.3	75.0	19.3
29. Manure and 50 pounds complete Fertilizer in row	53.3	14.6	89.0	20.3
30. Manure and 300 pounds Kainit broadcast	69.5	15.1	....	....

A study of these results show that the different treatments did not have much effect on the wheat crops. The results obtained with the use of a small quantity of fertilizer in the row at the time of seeding, and a larger quantity broadcast, gave practically the same result in Field 38, but showed decidedly in favor of the small quantity on Field No. 13. This can probably be explained by the fact that the seasons when the tests were made on Field No. 13 were much dryer than those with Field No. 38. This would substantiate the claim of many farmers that in dry seasons the use of more fertilizer than just enough to start the corn well is a disadvantage, as the larger quantities have a tendency to make a growth of fodder at the expense of grain.

The use of Kainit with the manure seemed to exert a beneficial influence every year, and it was more marked in dry than wet seasons. From the results here its use in conjunction with manure on corn can certainly be recommended.

(8) COMPARISON OF APPLICATIONS OF MANURE WITH APPLICATIONS OF WHEAT STRAW.

In order to determine the value of applications of straw to the land, tests were made of its use in comparison to manure. In some sections of the State many farmers make a practice of spreading surplus straw over the land. In other sections, where there are considerable amounts of straw almost going to waste, and relatively little manure made, it is very seldom that any of it is spread over the land in a fresh state.

The straw was applied at the rate of two tons per acre in the Summer or early Fall, and plowed down the following Spring. The following table gives the effects on the yields of corn and wheat:

TABLE XI.

	Corn Bushels.	Wheat Bushels.
Unmanured	34.0	16.3
Straw	58.3	19.0
Fresh Manure	86.1	22.1

These results show that the straw is not as valuable to apply as the manure, though it will produce a considerable increase in yield, and should be used fresh wherever available, rather than allow it to go to waste.

(9) EFFECT OF FRESH VS. ROTTED MANURE ON CRIMSON CLOVER.

It has been mentioned that in each rotation the first crop of corn was followed by Crimson clover, which was plowed under in preparation for the second corn crop. Since the clover was turned under it was not possible to accurately compare yields on the respective plots, but careful observations were made just before plowing. Though the clover was not particularly good in any case, it was noticeably thicker and taller on the fresh manure than on the rotted manure plots, and better on both series of manured plots than on the unmanured.

TABLE XII.

Average Yields of Corn in Field 38 in the First and Second Years of each Rotation.

	Corn Bushels.		
	Average of '01 and '05.	Average of '02 and '06.	Loss in Second Year
Unmanured (Ave. of plots 5, 10, 15, 20)	44.2	31.9	12.3
Fresh Manure (Ave. of plots 1, 3, 7, 9, 13, 16	79.9	61.9	18.0
Rotted Manure (Ave. of plots 2, 4, 8, 11, 14, 17)	74.8	55.4	19.4

This indirect effect of the fresh manure in contributing more humus and nitrogen through the medium of the Crimson clover may account to some extent for the slightly less falling off in the yields of the fresh manure plots as compared with the rotted manure plots in the second year of each rotation, as seen in the above table.

STAND OF CORN ON MANURED AND UNMANURED PLOTS.

During the progress of these manure experiments in Field 38, it was evident that the soil of all the plots was falling off in productiveness, the manure applied being insufficient to supply the drain involved in the removal of crops. In the manured crop the effect of this draft could be distinctly seen in the difference in the mechanical condition of the soil. It became lighter in color, lost much of its friability and porosity, became more sticky and dense, with a tendency to break into a hard surface crust, conditions which were aggravated by the unusually wet seasons, which interfered with the regular cultivation of the corn crops. As early as 1905 the changing conditions became evident on the unmanured plots, and showed their effect primarily in the poor stand of corn on these plots, as compared with those which had received manure. All of the plots were planted with seed as nearly equal in vitality as could be had, from tested ears, and well mixed after shelling.

On the manured plots the young plants came up promptly and regularly, and grew rapidly. On the unmanured plots they came up slowly and irregularly, and grew slowly, affording ample opportunity for insect depredation, from which they suffered severely. As a result the stand of plants on these plots was very poor. On September 25, 1905, just before the crop was harvested, a count was made of the plants on each plot, the results of which are given in Table 13. While no count of stalks was made in 1906, the relatively poor stand on the unmanured plots was apparent to the most casual observer.

TABLE XIII.

Showing number of Corn Plants per acre on Manured and Unmanured Plots in Field 38, September 25, 1907.

	No. of Plants per Acre.
Fresh Manure (Ave. of plots 1, 3, 7, 9, 13, 16)	8220
Rotted Manure (Ave. of plots 2, 4, 8, 11, 14, 17)	8170
Ave. of all Manured plots	8195
Unmanured (Ave. of plots 5, 10, 15, 20)	5440
Difference between Manured and Unmanured	2755

To this difference in the stand must be attributed much of the difference in yields of the manured and unmanured plots. That the difference in stand was attributable to the poor mechanical condition of

the latter plots, owing to their lack of humus, may be inferred from an inspection of Table 1, where it appears that the unmanured plots approximated more closely to the manured in the yields of wheat than of corn, it being generally recognized that wheat is better adapted than corn to succeed in dense, compact soils.

APPENDIX.

The matter printed in the appendix is given in order to answer the many questions of a miscellaneous character on manure that are not covered in the experiments conducted.

FARM MANURES.

DESIGNATION AND KIND OF FARM MANURES.

The term farm manures in its broadest sense is used to designate all materials (not included under green manures and commercial fertilizers) that may be made or accumulated on a farm, and which can be used for improving the fertility of the land, but the term is most commonly used to designate the excrements of domestic animals.

The term stable manures is used to designate manure just as it comes from the stables, and which is used in the fresh state. Yard or barnyard manure is the term applied to manure which has accumulated, or been kept for some time in a pile in the barnyard. The name of fresh manures is applied to manure that is only a few hours old, and as it comes from the stable. Rotted manure is the name used to designate manure that has gone through considerable fermentation, and more or less disintegrated. Mixed manure is the excrements of different species of animals, with the bedding or other material thrown together. Manure from a single species of animal is designated by the kind of animal producing it.

THE VALUE OF FARM MANURES.

The domestic animals kept in the United States produce annually several billions of dollars worth of manure. The value of manures varies considerably, depending upon, first, the kind and age of the animals; second, the kind and amount of food consumed; third, the kind and amount of absorbents employed; fourth, the system followed in collecting, preserving and utilizing the manure.

Even though these factors may vary greatly, the value of manure, when applied to the land, comes through the following influences:

(a) By contributing to the supply of plant food.
(b) By improving the physical condition of the soil.
(c) By inducing chemical changes.
(d) By introducing beneficial bacteria and ferments.

FARM MANURES AS A SOURCE OF PLANT FOOD.

While the composition of farm manure varies with the conditions already enumerated, yet they all supply more or less of the essential plant foods—nitrogen, phosphoric acid (phosphorous) and potash. The average mixed farm manure contains these plant foods in the proportion of approximately ten parts of nitrogen to six parts of phosphoric acid and eight parts of potash. Mixed stable manure contains on the average about 0.50 per cent. nitrogen, 0.30 per cent. phosphoric acid, and 0.40 per cent. potash. All manures contain as a rule both the dung and urine of animals, mixed with some absorbents. The dung consists chiefly of the undigested portions of the food consumed, which was first ground fine by the teeth, and then saturated and softened with the water and digestive fluids of the alimentary canal. This dung, while composed largely of the woody tissues of the food eaten, yet, being very fine and soft, will decompose and give up its plant foods very readily. Dung contains approximately one-third of the total nitrogen, one-fifth of the total potash, and nearly all of the phosphoric acid voided by animals. The plant foods in dung are not soluble, and must be decomposed before they can be utilized by plants. The urine of domestic animals contains compounds which have been formed in the body. It usually contains about two-thirds of the total nitrogen, four-fifths of the total potash, and very little of the phosphoric acid voided by the animal. While the elements found in the urine are in solution, yet they are not immediately available as food for plants, but become so much more quickly than the constituents found in the dung.

In practice it has been found that while farm manures furnish some of all of the essential plant foods, yet it is considered unbalanced, as it does not supply them in the proportions found most satisfactory in practice. This is due to the fact that soils gain nitrogen through other sources, and that the potash in soils becomes available through various means more rapidly than the phosphoric acid.

PHYSICAL EFFECTS OF MANURES.

As all farm manures contain a considerable percentage of organic matter, they have a marked influence in producing a better physical or mechanical condition in the soil to which they are applied. In fact, this value of improving the texture is often far greater than that derived from the plant food supplied.

In another connection it has been pointed out that many farm soils, even those that are unproductive and apparently worn out, contain large amounts of plant food; and that this can be largely *corrected* by improving the mechanical condition or texture.

When manure is incorporated with a soil it greatly improves the texture, loosening a heavy, compact soil, and binding together a light, leachy one, making the soil more friable, warmer, more retentive of moisture, and more congenial to plants in every way. Some experiments conducted by King, at the Wisconsin Station, showed that ma-

nured land contained 18 tons more water per acre in the upper foot of soil than similar land unmanured, and 34 tons more in the soil to a depth of three feet. Manure exerts a quicker beneficial influence on the texture of soils than green manures.

Manures will also aid in equalizing the supply and distribution of water in the soils.

Manure will make soils to which they are applied darker in color, and exert a material influence in making soils warmer.

Manured land is less subject to the denuding effects of wind and rain.

CHEMICAL EFFECTS OF MANURES.

Manures act chemically on soils, as already stated, by adding new stores of plant food, and by their decomposition in the soil they give off carbonic acid gas, which unites with the soil waters and increases its dissolving action on mineral plant foods. It also provides the formation of humates in the soil, and thus renders inert mineral plant food more available. The temperature of soils will be materially raised as a result of the chemical actions.

BACTERIAL INFLUENCES OF MANURES.

In addition to supplying plant food and vegetable matter, with their accompanying benefits, farm manures introduce into the soil a variety of bacteria and ferments, which also produce beneficial results. These bacteria, though great in number, have not been studied much in detail, and are little understood. It is very certain, however, that they are helpful in increasing the supply of available plant food. Farm manures have often the advantage over green manures in that the ferments introduced by the manure will result in an alkaline condition of the soil, while that from the green manure will be acid. Hence manure favors the nitrogen-gathering bacteria of legumes and nitrifying organisms.

Professor Chester of the Delaware Experiment Station, has found in a soil that had been liberally manured, and was producing at the rate of six tons of hay per acre several times as many bacteria as were found in the same soil which had little manure, and was producing about one ton of hay per acre.

FACTORS INFLUENCING THE VALUE OF MANURE.

The factors which influence the commercial and agricultural values of stable manures depend upon the following:

(a) The kind of animals.
(b) The age and condition of the animal.
(c) The food of the animal.
(d) The kind and quantity of absorbents used.
(e) The management of the manure.

Each species of domestic animal produces a manure of different quality, and with distinct characteristics. The most marked difference, as noted by its composition, is in the amount of water and organic matter which they contain.

CATTLE MANURE.

Cow or Steer manure contains considerably more water than that from any of our other domestic animals. It ferments and heats slowly, and is ranked as a cold manure. A cow will produce 40 to 50 pounds of dung or solid manure per day, and 20 to 30 pounds of urine or liquid excrement.

A cow fed a balanced ration will void about one-half of the nitrogen in the urine, about one-fourth in the milk, and the balance in the solid excrements.

HORSE MANURE.

Horse manure contains less water than cattle manure, and as the horse has less power to digest cellulose, the manure is more fibrous. Horse manure ferments easily, and hence is called a hot or quick manure. In fermenting, horse manure gives off ammonia or nitrogenous products, and rapidly deteriorates in quality. Because of the rapid fermentation of horse manure, it easily becomes dry and fires. To prevent fire-fanging and loss through fermentation, horse manure, when in piles, should be kept very compact and moist. Mixing horse manure with cow manure will aid in preserving it, and contribute to the value of both for general purposes. The quality of quick fermentation and heating makes horse manure especially valuable for use in hot-beds, mushroom beds and for cold, wet soils. Horse manure is more bulky, or weighs less per cubic foot, than cow manure. A well-fed horse will produce about fifty pounds of manure per day, about one-fourth of which is urine.

HOG MANURE.

Hog manure is a wet, cold manure. It ferments slowly. Its composition varies considerably, depending upon the food consumed. It is much like cow manure in its general characters, but usually much richer. A pig produces 10 to 15 pounds of manure per day.

SHEEP MANURE.

Sheep manure is usually richer and dryer than that from any other domestic animal except poultry. It ferments easily, and is classed as a quick-acting manure, but keeps well when allowed to accumulate in the pens where it is tramped hard by the animals. When placed in piles or composts it is benefited by mixing with cow manure. It is especially valuable for use on flowers or vegetables, when a quick-acting manure is desired. A sheep produces about four pounds of manure per day.

POULTRY MANURE.

Poultry manure is the richest of farm manures, but, like all others, it is variable in composition. It is rich in all the fertilizing elements, but especally so in nitrogen, which is due in part to the fact that the urinary secretions are semi-solid, and voided with the solid excrements. Poultry manure ferments easily, and is quick acting. It loses nitrogen and ammonia very easily, if not properly cared for. It should be kept dry, and if possible also mixed with some absorbent and preservative. Acid Phosphate, phosphate rock, plaster and dry earth are good materials for this purpose. Hard wood ashes, ordinary slaked lime, and such alkaline materials should be avoided, as they will liberate the ammonia, and cause it to be lost. A hen will produce 30 to 40 pounds of manure per year, and a turkey 40 to 60 pounds.

Average Yield and Composition of Fresh Excrements of Farm Animals.

DUNG—SOLID EXCREMENTS.	Excreted per Year.	COMPOSITION.			
		Water.	Nitrogen.	Phosphoric Acid.	Potash Soda.
	Lbs.	%	%	%	%
1. Cows	20000	84.0	0.30	0.25	0.10
2. Horse	12000	76.0	0.50	0.35	0.30
3. Pigs	1800	80.0	0 60	0.45	0.50
4. Sheep	760	58.0	0.75	0.60	0.30
5. Hen	....	48.6	1.38	0.50	0.41
URINE—LIQUID EXCREMENTS.					
1. Cows	8000	92 0	0.80	Trace.	1.4
2. Horse	3000	89.0	1.20	Trace.	1.5
3. Pigs	1200	97.5	0.30	0.12	0.2
4. Sheep	380	86.5	1.40	0.05	2.0

THE EFFECT OF THE AGE AND CONDITION OF ANIMALS ON THE MANURE.

The quality of manure is materially influenced by the age, condition and uses made of the animal. An animal which is making growth will yield a poorer manure than animals similarly fed that have completed their growth, as the materials for forming bone, muscle, blood, etc., must be extracted from the food. The elements chiefly affected are the nitrogen and phosphoric acid. Animals in poor condition, and being fed for the production of flesh, leave considerable less nitrogen in the manure than those in normal condition. Fattening animals produce a rich manure, as they are at rest and storing almost exclusively fat, which uses very little of the plant food elements.

Animals that are bearing young, or are producing milk, eggs or wool, utilize considerable nitrogen and phosphates and some potash in their production, and the excrements are poorer in plant foods to that extent.

MISCELLANEOUS FARM MANURES.

There are a variety of materials that may be available as manure on many farms, and it is well for farmers to utilize them whenever possible. The ones most commonly met with are described below:

NIGHT-SOIL AND POUDRETTE.

These are terms used to designate human excrements. The name night-soil probably had its origin from the fact that this material is usually handled in towns and cities during the night. The term poudrette has been given to the dried excrements which are manufactured in some places.

In order to use night-soil to any advantage, it is best to compost it with some good absorbent, such as loam, muck or peat. It is estimated that the excrements of a man for one year contains about eleven pounds of nitrogen, two and one-half pounds of phosphoric acid and two pounds of potash.

The night-soil gotten in Baltimore, and used extensively by truckers in that section, and popularly called "soup," contains 2.7 per cent. total solids, 0.28 per cent phosphoric acid, 0.2 per cent. potash and 0.43 per cent. ammonia, and has a value of about $1.50 per ton.

MUCK AND PEAT.

These are names used to designate partially decayed vegetable matter which has accumulated in marshes, swamps and shallow ponds. It is quite variable in composition, generally ranging from one-half to two per cent. of nitrogen, and only traces of phosphoric acid and potash. They are quite valuable for use on sandy soils, and on very stiff clays. The better classes make good bedding and absorbents.

LEAF MOULD.

This is a term applied to a more or less decayed accumulation of leaves in the woods.

It is especially valuable for some special classes of gardening or truck crops. It is costly to gather, and its removal is more or less harmful to the forest trees.

It contains about twenty pounds of nitrogen, three and one-half pounds of phosphoric acid, and five pounds of potash per ton.

SEA WEEDS.

Along the sea border there is considerable quantities of sea weeds washed ashore from time to time, and most of these are fairly rich in plant food, and afford a good source of manure.

They contain from 5 to 12 pounds of nitrogen, two to five pounds of phosphoric acid, six to twelve pounds of potash per ton.

THE INFLUENCE OF THE FOOD OF ANIMALS ON MANURE.

From 50 to 90 per cent. of the fertilizing elements in the food is found in the excrements of animals, depending upon their age and the functions being performed.

Cows in milk return 65 to 75 per cent. of the manurial value of the food, while fattening cattle returns 80 to 90 per cent.

The kind of food that the animal eats has a marked effect upon the richness of the manure. The richer the ration, the richer the manure. From the composition of the more common feeding stuffs, as compiled in the following table, some idea can be gained of the relative influence of feeds on the value of manure.

Fertilizing Ingredients in Common Cattle Food.
Pounds in One Ton.

	Water.	Nitrogen	Phosphoric Acid.	Potash.
GREEN FODDERS				
Corn fodder	1580	8.2	3.0	6.6
Corn silage	1600	8.4	2.6	7.8
Cow peas	1672	5.4	2.0	6.2
Clover	1416	10.6	2.6	9.2
Rye	1532	6.6	3.0	14.6
HAY AND FODDER :				
Corn stover	400	18.4	5.2	24.4
Clover hay	300	40.0	8.2	42.2
Timothy hay	300	23.8	6.6	28.0
Red top hay	188	23.0	7.2	20.4
Orchard grass hay	198	26.2	8.2	37.6
Millet hay	300	24.4	9.2	32.2
Alfalfa hay	168	43.8	10.2	33.6
GRAIN.				
Corn	218	.	14.0	8.0
Oats	180	42.0	13.6	9.6
Barley	218	30.2	15.8	9.6
Wheat	210	47.2	15.8	10.0
Rye	232	35.2	16.4	10.8
MILL PRODUCTS :				
Cotton seed meal	164	134.0	49.4	36.6
Linseed meal	160	116.6	34.0	25.0
Gluten feed	164	74.4	6.8	1.2
Distillers grains	....	96.0	....	....
Malt sprouts	204	71.0	28.6	9.6
Brewers grains	164	72.4	20.6	1.8
Hominy chop	222	32.6	19.6	9.8
Wheat bran	198	47.2	42.0	28.0
Wheat Middlings	204	55.0	25.0	15.0

BEDDING, LITTER OR ABSORBENTS.

Many materials are used for bedding, and these affect the value of the manure.

The objects sought in materials used for bedding are as follows:

1. To make the animals a comfortable bed, and keep them clean.
2. To absorb and retain the urine and watery manure.
3. To dilute and improve the mechanical condition of the manure, and make it easier to handle.

The materials used for bedding are generally not rich in fertilizing constituents, and to some extent tend to dilute the manure; but as they absorb and hold the valuable liquid parts, which are easily lost, they really improve the quality.

Straw is the most universal bedding material in use, and it fulfills most of the requirements very satisfactorily. It is abundant on most farms, as it is in a measure a waste or by-product, and has no market. There are many other materials that have better absorbent powers than straw, and are relatively cheaper when bedding must be purchased.

Dust Absorbents.—In order to help absorb liquid manures, and prevent the loss of volatile ammonia compounds, dust absorbents are used. Good materials for use in this way are land plaster (gypsum), kainit, finely ground phosphate rock and phosphate, fine earth and sand.

The use of such materials as furnish phosphoric acid and potash are especially valuable, as they enrich the manure in these plant foods.

The following table gives the materials most commonly used for bedding, with their composition and relative water-absorbing power:

	Fertilizing Constituents in One Ton.			
	Nitrogen.	Phosphoric Acid.	Potash.	Water absorbed by 100 lbs.
	Lbs.	Lbs.	Lbs.	%
Wheat Straw	9.6	4.4	16.8	220
Rye Straw	11.2	5.1	18.1	....
Barley Straw	11.4	5.0	23.5	....
Oat Straw	14.4	3.6	23.0	....
March Hay	....	....	....	....
Corn Fodder (final cut)	17.2	10.6	54.0	250
Peat	20.0	....	....	600
Sawdust	4.0	6.0	14.0	435
Leaves	15.0	3.2	6.0	162
Spent Tan Bark	15.0	....	....	450

Experiments conducted by the Maryland Experiment Station (Bulletin No. 104), on bedding, give some results that are interesting in this connection.

Absorptive Properties and Relative Cost of different Bedding Materials.

Material.	Water absorbed per pound of Bedding.	Pounds of Bedding required to absorb liquid manure from 1 Cow 16 hours.	Pounds of Bedding required to absorb for 24 hours.	Yearly cost for Cow stabled 16 hours per Day.	Yearly cost for Cow stabled 24 hours per Day.
Cut Stover....	2.5 Lbs.	2.8 Lbs.	4.0 Lbs.	$2.55	$3.65
Cut Wheat Straw.......	2.0 "	3.3 "	5.0 "	3.61	4.82
Uncut Wheat Straw.......	2.0 "	3.3 "	5.0 "	3.11	4.15
Sawdust.......	0.8 "	3.3 "	12.5 "	.11	.45
Shavings......	2.2 "	3.0 "	4.4 "	3.28	4.81

The prices assumed in the table for these different materials would, of course, vary considerably in different seasons and different localities. The cut stover was valued at $5.00 per ton, the uncut straw at $5.00 per ton, the sawdust at 20 cents per ton, and the shavings at $6.00 per ton. It costs about one dollar per ton to cut straw, and a little less to cut the stover. Stover uncut was valued at $4.00 per ton. These were about the relative values on the farm, basing the calculation on the selling price in this section. It will be seen that at the relative prices given cut stover was much more economical than was the uncut straw, and the uncut straw more economical than the cut straw. The shavings cost practically the same as the cut straw. But the shavings were so much more satisfactory, in every other way, that they would more than compensate for the extra cost. Especially is this true where any effort is being made to produce first-class milk.

The relative cost of the sawdust presents an interesting feature. This sawdust was purchased from a nearby sawmill, and the cost assumed for the calculations given was the price paid at the mill—twenty-five cents per load. It might have been well to consider the cost of hauling, which was fifty cents per load. Even this could have been added to the assumed price, and still made the sawdust by far the cheapest bedding used. Then, too, as was emphasized before, the sawdust was ideal for this purpose. The conclusion is evident that wherever sawdust can be obtained it would pay to use it for bedding. This would be true even when plenty of corn stover or straw was at hand, for the straw and the stover could be sold, and money saved in buying the sawdust.

WASTE OF MANURE.

Even though manure is regarded highly by all farmers in sections where fertilizers are needed, nevertheless there is probably no product of equal value which is so much neglected and so poorly cared for.

The first great source of loss is through the incomplete absorption of the urine. It is not infrequent to see no attempt being made to save this portion of the manure. When it is remembered that the urine is richer in both nitrogen and potash than the dung, and that they are more available to crops in the urine than in the dung, it should be self-evident to all that it is highly essential that this part of the manure be carefully saved.

The second greatest source of waste of manure is the loss incurred by leaching. If manure is piled against the side of the stable where the water from the roof can drip on it, or if it is piled on the hillside, or other exposed places, the rain water in leaching through the manure washes out of it much nitrogen and potash, which is seen in the dark-brown liquid oozing from the base of the pile.

The third common source of loss is that incurred by heating and fermenting. When manure is thrown in piles it soon heats and throws off more or less vapor and gas. This heating is caused by fermenting or breaking down of the materials composing the manure. The fermentation is caused by the action of bacteria or low orders of microscopic plants. The bacteria which produces the most rapid fermentation in manure need plenty of air or oxygen. Therefore, fermentation will be more rapid in loosely piled manure. A certain amount of moisture is necessary for fermentation, but if the manure is wet fermentation is checked, because it lowers the temperature, and excludes part of the supply of air. The fermentation which takes place in manure breaks down the organic matters, and cause a loss of humus, and also of nitrogen through the ammonium compounds, which are volatilized. The odor of ammonia, which is commonly noticeable about horse stables and piles of horse manure, is an evidence of the fermentation and loss which is taking place.

Fresh manure loses in the process of decay from 20 to 70 per cent. of its original weight. An 80 ton heap of cow manure left exposed for one year lost 66 per cent. of its dry substance. Some tests conducted by the Cornell Experiment Station showed that 2 tons of horse manure exposed in a pile for five months lost 57 per cent. of its gross weight, 60 per cent. of its nitrogen, 47 per cent. of its phosphoric acid and 76 per cent. of its potash. Five tons of cow manure exposed for the same length of time in a compact pile lost 49 per cent. of its gross weight, 41 per cent of its nitrogen, 19 per cent. of its phosphoric acid and 8 per cent. of its potash.

While manure may lose a large per cent. of their valuable constituents, yet they may be worth more per ton than they were before the loss occurred; because the plant foods remaining are concentrated into a less quantity of material.

CARE OF MANURE.

The first step to be taken in the care of manure so as to prevent the losses mentioned above is to provide sufficient bedding or litter in the stable to absorb and save all the liquid parts. The losses due to

fermentation can be greatly checked by mixing horse manure with the older cow manure, by making the piles compact so as to exclude the air and by moistening the pile so as to assist in excluding the air and also to lower the temperature. The use of chemical or mechanical absorbents such as paste, kainit, phosphate rock, etc., in the stable and sprinkled over the manure assists in preserving the manure and preventing loss. Losses from washing or leaching by rain may be prevented by piling under cover or in favorable basin like places, or still better by hauling it directly to the field and spreading it as soon as produced.

APPLICATION OF MANURE.

In order to reduce the loss in manure to a minimum, and also to economize in handling it, the general aim and practice should be to haul it directly from the stable to the field and spread it at once. On the average farm the following of this practice all through the year would result in less loss than any method that could be pursued.

The use of rotted manure rather than fresh manure is desirable in connection with many market garden or vegetable crops, as it gives quicker results and with root crops will give a smoother and nicer product.

Manure should be spread as soon as it is hauled to the field. The practice of putting it in piles is objectionable because of the loss that is likely to occur. The placing in piles also involves additional labor.

The manner of spreading will depend upon local conditions, but where the distance to haul is relatively short and it is desired to have it evenly spread the manure spreaders will be found serviceable machines.

From 10 to 20 tons of manure per acre is usually considered a fair application; but considerable more is frequently applied for market garden crops. Experiments have shown that generally it would be far more profitable to use about one-half the usual quantities and to supplement it with commercial fertilizers.

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SPRAYING FOR SAN JOSE SCALE.

By T. B. Symons and G. P. Weldon.

INTRODUCTION.

The importance of properly treating orchard trees for control of the San Jose Scale and other injurious insects, has been so thoroughly brought to the attention of orchardists during the last few years that there can be no excuse for a grower to allow his trees to be severely injured or killed by them. All observing and up-to-date orchardists know well enough the necessity of treatment for insect enemies of fruit trees, and they are realizing more and more that the commercial buyer seeks, and is willing to pay more for fruit which has been given the best of attention. There is plenty of evidence to convince even the most unreasonable man that his trees must be given this attention, not only to save them, but in order that he may secure a fair return for capital invested.

The San Jose Scale is present on a large majority of fruit trees in the towns and cities of the State, as well as in orchards. Because of this fact, the Department inaugurated the plan of conducting public sprayers. The policy has been to make this work self-supporting by charging the owners so much per tree, to cover the cost of labor and the materials used. This work was commenced on a small scale last spring, and proved very satisfactory. It was found that in the towns and cities all owners of trees would gladly pay a reasonable amount to have their trees properly treated, but they could not afford, in many cases, to do this work themselves, and in still others would not take the trouble. This phase of the work proved an innovation, and it is believed that it is the first instance of a State Department conducting public sprayers. A more elaborate discussion of their operation will follow in this bulletin.

In giving the report of the work with the San Jose Scale, during the past year, it will be seen that the results of the experiments more thoroughly substantiate the previous recommendations. In addition they give to the orchardists of the State up-to-date information as to the effectiveness of the various insecticides employed in the control of the San Jose Scale. It is necessary, in order to be able to answer

inquiries intelligently, to determine the efficacy of all new washes on the market, and compare it with that of the standard remedies. The Station is always pleased to co-operate with manufacturers in testing any new remedy, but its recommendations will be based on the effectiveness, as shown by actual results, irrespective of the published claims of the manufacturer.

It seems desirable to reiterate the statements made in Bulletin No. 112 that when an orchardist wishes to try a new insecticide for the control of any pest, which already has a known remedy, that he use such new remedy on a few trees at first. Remedies which have proved efficient often present some undesirable features. These undesirable features the experimenter hopes to find eliminated in the new one. Whether or not they will, can only be determined by a careful comparison of results obtained from using both the standard and the new.

STATUS OF SAN JOSE SCALE IN STATE.

The reports of our local inspectors during the past year indicated a great increase in the number of orchardists spraying, and the desire on the part of growers for more information along these lines. In many parts of the State the pest is looked upon as a benefit to the orchard industry, due to the fact that better care of trees is necessitated. In other parts it is hardly recognized, and therefore is doing considerable injury. More new territory has been covered by the local inspectors the past year than ever before, and it is hoped that in these parts the efforts expended on behalf of the growers, will be evidenced by better attention to trees and better fruit.

It seems necessary to again warn the orchardists of the State in regard to the distribution of the San Jose Scale from the Osage Orange Hedges, which stand as a menace in many localities, as they are invariably infested. All such hedges should either be destroyed, or thoroughly and regularly treated with an effective remedy. The inspection and enforcement of the State Horticultural Law has been conducted as vigorously as means would permit, and it is believed that conditions are steadily improving in all parts of the State which have been visited by the inspectors.

EXPERIMENTS.

In experimenting with patent insecticides, manufactured for the control of San Jose Scale, there are several essential points that must be taken into consideration, in order that results will be indicative of the true worth of the materials used. Most important of all is the selection of the orchard. Trees in an experimental orchard should be very badly infested with scale. This is absolutely necessary for a proper test. It is known from years of experience with the lime and sulfur wash that it will give satisfactory results, if the vitality of trees

is not too low as a result of the scales' attack. The only way to judge of the efficiency of the patent preparations is by a comparison of the good accomplished by their use, with that accomplished by the use of lime and sulfur under the same conditions. Not only should trees in the experimental orchard be badly infested with scale, but, on the other hand, they should receive the cultivation necessary to keep trees growing, and in a healthy condition. The ideal orchard for an experiment is one in which these two features are combined. Needless to say, such an orchard is hard to find, for the person who carefully tills and looks after the soil conditions of his orchard will also spray to prevent injury from insect attack. An orchard poorly kept, and grown up with weeds, is unsatisfactory. Often when very scaley trees are sprayed they are low in vitality, and even though the spray may be entirely successful in killing the insects, the trees will not recover. The question now arises, was the tree killed by the spraying mixture, by the scale, or by poor treatment of soil, or by a combination of all these causes?

The orchard being selected, care should be exercised in mixing the insecticides, so that they do not separate out, but maintain a thorough and uniform mixture. The correct proportions should also be carefully measured, so that the proper strength to use may be accurately determined. Spraying should be done thoroughly, and every part of the tree should be covered.

For the experiments recorded in this bulletin two orchards were selected, one belonging to Mr. Frank W. Hill, of Upper Marlboro; the other to Mr. J. P. Ford, of Boonsboro. Thanks are due these gentlemen, who kindly aided in every way, so that the work might be carried to a successful termination.

The trees were all very badly infested, as none had received treatment the previous year. Mr. Hill's orchard was sprayed in the Fall; Mr. Ford's in the Spring—the former November 23, 1906, the latter April 4 and 5, 1907. The weather at the time of spraying Mr. Hill's orchard was dry, but very windy, which made it exceedingly difficult to thoroughly cover a tree without great waste of materials. The trees had not been trimmed, and were very full of a growth of slender branches, which fact also added to the difficulty in doing thorough work. Three different strengths of each petroleum insecticide were used, viz: The recommended strength of one gallon of the mixture to 20 of water; double this strength, or one gallon of the mixture to 10 of water, and one gallon of the mixture to 15 of water. Rex brand lime and sulfur was used, at the strength of one gallon of the mixture to 10 gallons of water.

Mr. Ford's orchard was sprayed a trifle late in the season, and much injury to buds resulted, and in a few cases to the whole tree. These trees were just coming into bloom, and should have been sprayed at least a week earlier in the season. The fact that the fall spraying of Mr. Hill's orchard did not injure a single tree, would seem to indicate that injury to Mr. Ford's trees was due to the lateness of the spraying,

and not to the kind of insecticides used. Some of the trees were, however, very badly encrusted with scale, and evidently did not have enough vitality left to bring about recovery, even though the scale was all killed. The soluble oils applied to this orchard were all used at three different strengths, viz: one gallon to 10 of water, 1-15 and 1-20. Rex brand lime and sulfur was used in two strengths, 1-9 and 1-10; Salamine in two strengths, 1-15 and 1-20; Lion brand California wash in one strength, 1-25. Lime and sulfur made according to the formula recommended in this bulletin was also used on a number of the trees.

Each orchard was examined twice after spraying, and the results of each mixture carefully noted. Mr. Hill's orchard was examined April 18 and October 15. Mr. Ford's was examined July 12 and October 18.

Results.

Kil-o-Scale, 1 gallon to ten of water.

Forty-nine trees were treated. Boonsboro orchard, 38 peach; Marlboro orchard, seven apple and four peach.

General results were good. A few scales bred on all trees, but in no case did they develop in sufficient numbers to do the trees any injury for the season. Some injury to the trees at Boonsboro was caused by this strength of the mixture.

Kil-o-Scale, 1-15.

Thirty-eight trees were treated with this strength, all of them at Boonsboro. Results were good. Very little scale bred during the summer, and with the exception of slight injury to the trees from spray, results were satisfactory.

Kil-o-Scale, 1-20.

Thirty-seven trees were treated. Boonsboro orchard, 24 peach; Marlboro orchard, 13 peach.

Although good was accomplished with Kil-o-Scale at this strength, on the whole it was unsatisfactory. Much more scale bred than where the higher strengths were used. Three trees in the row sprayed at Marlboro, with this strength, were left for checks. These were covered with live scale, and were not nearly so thrifty as the sprayed trees in the row. It only needed a casual glance to convince one that the spraying had done some good, though not enough to be considered satisfactory.

Target Brand, 1-10.

Forty-four trees were treated. Boonsboro orchard, 32 peach, Marlboro orchard, five apple and seven peach.

This mixture gave good results on the Marlboro orchard, with the exception of one apple tree, upon which the scale had bred freely. At Boonsboro general results were good. Only a few scales had bred on each tree. Many trees were quite severely injured, but none killed.

Target Brand, 1-15.

Thirty-four trees were treated, all at Boonsboro. Results about the same as above. Slight injury was noticed on many of these trees.

Target Brand, 1-20.

Thirty-five trees were treated. Boonsboro orchard, 24 peach; Marlboro orchard, 11 peach.

More good resulted from this strength at Marlboro than at Boonsboro. At the former place very little scale had bred during the summer; at the latter place it had bred quite freely. One large tree in the Boonsboro experiment was killed, apparently by the spray, and others quite severely injured. It could not be determined why the weaker strength of this mixture should have done more damage to the trees than the stronger, but such seemed to have been the case.

Scalecide, 1-10.

Fifty-seven trees were treated. Boonsboro orchard, 45 peach: Marlboro orchard, 12 peach.

The Marlboro orchard showed better results than did the one at Boonsboro. The trees in the former made an excellent growth, and very little live scale could be found, except upon one tree. These seemed to be confined principally to one branch, which had probably been missed in the spraying of tree. Final examination at Boonsboro revealed just fair results. Scale had bred more or less on all trees sprayed.

Scalecide, 1-15.

Forty peach trees were treated at Boonsboro.

Results were fair. Scale had bred about the same as in above experiment.

Scalecide, 1-20.

Twenty-seven trees were treated. Boonsboro orchard, 20 peach; Marlboro orchard, three peach and four apple.

Fair results in Marlboro orchard, good on peach and poor on apple. At Boonsboro scale had bred freely on all trees. Much good was accomplished, but in general results were unsatisfactory.

Soluble Petroleum, 1-10.

Fifty-one trees were treated. Boonsboro orchard, 37 peach; Marlboro orchard, nine peach and five apple.

This mixture proved very satisfactory on both orchards. A careful examination of trees failed to reveal the presence of live scale, except in very small numbers. Trees in the Marlboro orchard sprayed with both strengths were very thrifty, and had made an excellent growth, though they were very scaly at the time of treatment.

Soluble Petroleum, 1-15.

Forty peach trees were treated at Boonsboro.

Somewhat more live scale was found than where the higher strengths were used. General results were good.

Soluble Petroleum, 1-20.

Thirty-four trees were treated. Boonsboro orchard, 20 peach; Marlboro orchard, 14 peach.

As stated above, the trees at Marlboro that were sprayed with this strength were thrifty, only a few scale having bred upon them. This strength was not satisfactory on the Boonsboro orchard. Much more scale bred upon these trees than where the higher strengths were used.

Rex Lime and Sulfur, 1-9.

Approximately 100 peach trees sprayed at Boonsboro.

Next to lime and sulfur, made according to the ordinary formula, this mixture proved more satisfactory than any other, with the possible exception of the soluble petroleum. Trees sprayed on April 5 were still quite white with the lime when examined on October 18. Scarcely any scale had bred. Before spraying some of the trees were almost dead, so bad was the scale. Nearly all revived after the spraying.

Rex Lime and Sulfur, 1-10.

Thirty trees were treated. Boonsboro orchard, 20 peach; Marlboro orchard, 10 peach.

This strength proved equally as satisfactory as the other. All trees sprayed with Rex Lime and Sulfur were in good condition, as regards scale.

Salamine, 1-15.

Thirty-five peach trees were treated at Boonsboro.

No good accomplished. Scale bred as freely as though no spray had been applied. This experience with this mixture was the same as that reported by several orchardists in other parts of the State. Upon examination of a couple of these orchards they were found to be in no better condition than before the application was made.

Salamine, 1-20.

Forty-eight peach trees were treated at Boonsboro. Same results as above.

Lion Brand California Wash, 1-25.

Forty-eight peach trees were treated at Boonsboro.

This mixture also proved unsatisfactory. Apparently no good was accomplished from its application.

Lime and Sulfur, Regular formula.

About 200 trees were sprayed at Boonsboro. The usual good results of this wash were apparent here. Very little scale had bred; much less than on trees treated with the other washes.

Check Trees.

Boonsboro orchard, eight; Marlboro orchard, four.

All check trees contained a large amount of live scale, which had bred freely throughout the summer. The only trees upon which as much was found were those that were sprayed with Salamine and Lion Brand California Wash. All others showed results of the spraying.

SUMMARY.

With the exception of Salamine and Lion Brand California Wash, good was accomplished with all mixtures. In no case did a petroleum

mixture prove so unsatisfactory that it should be condemned for general use. On the other hand, results were such that they could be recommended as partially satisfactory, at least.

These experiments confirm results of previous ones carried on by this Department, that the recommended strengths of many patent insecticides are not strong enough to do the work in a thorough manner. Hence, when used they should be at least a third stronger than is usually recommended by the manufacturer.

It is doubtful whether anyone would be justified in giving up the lime and sulfur wash for any of these patent remedies, for its superiority is unquestionable, and it is certainly the most economical.

TABULATED SUMMARY OF RESULTS.

Insecticide Used.	trength.	Number f Trees Sprayed.	Injury.	Results in Killing Scale.
Kil-o-Scale.........	1–10	49	Slight	Good
Kil-o-Scale.........	1–15	38	Slight	Good
Kil-o-Scale.........	1–20	37	None	Unsatisfactory
Target Brand......	1–10	44	Severe	Good
Target Brand......	1–15	34	Slight	Good
Target Brand......	1–20	35	Severe	Fair
Scalecide	1–10	57	None	Fair
Scalecide	1–15	40	None	Fair
Scalecide	1–20	27	None	Fair
Sol. Petroleum	1–10	51	None	Very Good
Sol. Petroleum.....	1–15	40	None	Good
Sol. Petroleum.....	1–20	34	None	Fair
Rex Lime & Sulfur.	1–9	100	None	Very Good
Rex Lime & Sulfur.	1–10	30	None	Very Good
Salamine	1–15	35	None	Very Poor
Salamine	1–20	48	None	Very Poor
Lion Brand Cal. Wash	1–25	48	None	Very Poor
Lime and Sulfur...	Regular formula	200	None	Very Good
Check Trees.......		8		Very Scaly
Total trees in experiment.........	....	955		

DIRECTIONS FOR MAKING LIME SULFUR WASH.

We continue to recommend the Lime Sulfur Wash as the most efficient, economical and satisfactory remedy for the San Jose Scale. For the benefit of those persons who are not as yet familiar with its use, it is deemed advisable to again give what is considered the best formula and method of making. There is considerable latitude in the quantity of materials used, and in the manner of making the mixture within which uniformly good results may be obtained. These points were thoroughly discussed in Bulletin 112, issued last Fall. It is only necessary to say here that the materials can be boiled in a home-made vat, or hog scalder, or if steam is desired, in a small boiler, such as is shown in Figure 1. This type of boiler was used with the public sprayer. A regular steam engine can be employed where it is desired to make the wash on a large scale.

It may also be well to repeat that there is practically no difference in the use of flour or flowers of sulfur in making the wash, and as the flour of sulfur is the cheaper, it would seem more practical to employ this grade.

FORMULA:

Stone Lime	20 lbs.
Flowers or flour of sulfur	15 lbs.
Water to make	50 gals.

DIRECTIONS:—Put twenty gallons of water in an iron vat, or hog scalder, and bring to a boil; then add the stone lime and sulfur. The sulfur should be made into a paste, with hot or cold water, before placing it in the boiler, in order to facilitate its mixing. After the lime and sulfur have been boiled for some time, salt* may be added, if desired. Boil the mixture, stirring occasionally, from thirty minutes to one hour, or until the sulfur is thoroughly dissolved, and a clear, amber-colored solution produced. Then dilute by adding sufficient hot or cold water to make fifty gallons. Pass the mixture through a strainer, with at least twenty meshes to the inch, into the spray barrel, and apply to the trees warm.

TIME OF APPLICATION.

No particular difference has been observed in the effectiveness of the lime sulfur wash, whether applied in the Fall or early Spring, during the dormant season. It is believed, however, that early Spring is the best time to spray, as the mixture will remain on the trees for a longer period during the summer, when the scale is breeding, and this is desirable. In some cases, where there is a great amount of spraying to be done, it may be necessary to do a part of it in the late Fall, as

*NOTE:—While salt is not a necessary ingredient of the wash, ten pounds can be used, if desired.

Figure 1.—Showing small boiler used to boil lime-sulfur wash for public sprayer.

often in the Spring weather conditions prevent an extended period for the work, and other Spring work may interfere. It is safe to say that 90 per cent. of the spraying in Maryland is done in the Spring, and there is little doubt but that period is preferable. It must be borne in mind that the lime sulfur wash is a treatment for dormant trees, and should not be applied after the buds open in the Spring.

MODE OF APPLICATION.

No matter how good the materials used, or how well the wash is made, if the spraying is not done thoroughly the results will be disappointing. Too much stress cannot be made upon this important phase of the work. One of the advantages of the lime sulfur wash is that after the spray has dried on a tree the twigs or limbs that have been missed are easily seen. Such trees should be gone over a second time. Especially should the terminal parts be thoroughly covered, as the young insects always seek the new, tender wood.

If a few infested trees have been found in an orchard, spray the whole orchard. The pest is always more thoroughly distributed than an inspection would ordinarily indicate.

In the selection of a pump for spraying purposes, the particular size, etc., is left to the judgment of the orchardist. The majority of the pumps on the market will give satisfaction, and conditions under which spraying is done are so varied that only general recommendations could be made. There is no doubt that the ordinary barrel pump is more generally used than other kinds, but the power sprayers and double-acting pumps have their place, where there is a large amount of work to be accomplished.

Spraying, at best, with any insecticide or fungicide, is rather disagreeable work, and the sprayman should be fitted out with rubber or oilskin coat, hat and gloves. It is also a good plan to rub vaseline on the hands and face to prevent the spray from irritating the flesh. Make it a point to have a sufficient length of hose—twenty feet to each lead should be the minimum length for orchard work. This will enable the spraymen to go all around an ordinary-sized tree without moving team. Good extension rods are necessary, and will aid him in keeping out of the spray. What is stated above in regard to the different pumps may also be said of the different nozzles on the market. Some prefer the fan-shaped, others a conical spray.

In conclusion, select the best apparatus suited to one's needs, and conduct the work in a thorough manner.

The following are manufacturers and dealers in pumps and supplies:

Griffith & Turner Co., Baltimore, Maryland.
Goulds Manufacturing Co., Seneca Falls, New York.
The Deming Co., Salem, Ohio.
Morril & Morley, Benton Harbor, Michigan.
Field Force Pump Co., Elmira, New York.

Myers Pump Co., Ashland, Ohio.
George H. Stahl, Quincy, Illinois.
Spray Motor Co., Buffalo, New York.
L. G. Orndorff, No. 203 Seventh St., Washington, D. C.
F. W. Bolgiano & Co., No. 935 M St., N. W., Washington, D. C.

SUMMER TREATMENT.

When a serious infestation is observed during the summer months, and treatment is desired to hold the pest in check until the dormant period, 20 per cent. Kerosene Emulsion, applied on sunny days, will serve to kill the crawling young, and many of those scales recently settled. This treatment only serves as temporary relief, or until the regular dormant washes can be applied.

The following method is used in making the emulsion:

Water—five gallons.
Ordinary hard soap—one and one-half pounds.
Kerosene—ten gallons.

Pour the ten gallons of kerosene into a spray barrel. Dissolve the soap in the five gallons of boiling water, and pour soapy water, while hot, into the barrel, with the kerosene. Emulsify by pumping the mixture back into itself for at least fifteen minutes. Add thirty-five gallons of cold water, and the mixture is ready to apply.

If Tak-a-Nap Soap can be secured, the Emulsion can be made as above, using ten pounds of the soap without heating the water.

OPERATION OF PUBLIC SPRAYERS.

For several years it has been the aim of the Department to encourage private enterprise in the establishment of public sprayers, to be used in small orchards and villages. It has also been the aim to impress on all commercial orchardists the desirability of their owning and operating their own pumps. As a rule, the farmers and orchardists throughout the State have found the owning of a barrel pump a necessity for the proper treatment, not only of orchard trees, but also of other crops, as well as being useful in whitewashing and the disinfection of stables, poultry-houses, etc. While some public sprayers have been conducted from time to time, mostly in the large orchard districts, the business has not proved to be attractive, or a financial success. The failure has generally been due to a want of proper equipment. It has been apparent for some time that in order to induce residents of towns and cities to effectively treat their fruit and shade trees, invariably infested with San Jose Scale, and other pernicious insects, there must be a means whereby they can have this work done at a reasonable cost, and with little trouble. It is the rule that such men are engaged in business, which does not permit their giving time to home matters of this nature, even if they had the inclination, and could afford to procure the necessary apparatus for the proper conduct of this work.

With a view to demonstrating to the public that such a business can be conducted successfully, this department, upon approval of the Board of Trustees, established three public sprayers, locating them in different parts of the State, viz., Prince George, Frederick and Talbot Counties. As stated previously, the idea was to make them self-supporting, by charging so much per tree to cover the actual cost of operation. As was anticipated, the greatest difficulty in their operation was to secure efficient labor. This phase of the problem proved serious in conducting the work in Frederick County, which, owing to circumstances, could not be given personal attention. In order to give a description of the work accomplished by the use of these sprayers, it will suffice to discuss one at length.

WORK IN PRINCE GEORGE COUNTY.

The continued requests for the service of a public sprayer in this locality prompted the Department to locate one sprayer here. The fact that this territory was close at hand was also an advantage. The lime sulfur wash was employed in all the work. If any of the so-called patent washes prove entirely satisfactory they could be used in such work with much more advantage, as it would obviate the necessity of cooking, which must be done with the lime sulfur wash. The aim in locating a sprayer in this vicinity was to spray all trees in the towns along the Baltimore and Ohio Railroad between Hyattsville and Laurel. This was practically accomplished. The outfit was placed in charge of Mr. W. C. Traverse, who solicited the work, and superintended the operations of the apparatus and men, with satisfaction.

Owing to the delay in securing the barrel pump and the small boiler which was used in making the solution, actual spraying did not commence until March 26. From that time until April 25, when the buds had advanced so that it was inadvisable to continue longer, spraying was done every day except when interrupted by unfavorable weather. In all, forty-five places were visited, and about 2,500 trees treated.

Of course, much time was taken up in moving from place to place, and on some days more time was occupied in this way than in spraying. The boiler and stock of materials were located in a central place in the town, where the solution was made. It was hoped that a charge of five cents per tree would cover all expenses, but the charge of $3.00 per day for horse and cart, an average of $6.67 per day for labor, cost of materials used, general wear on apparatus, also the loss of time in moving, as many citizens had such a small number of trees, made it necessary to increase this amount to ten cents per tree in order to make the work self-supporting. These expenses were exceptionally high, however, and it is thought that with better arrangements and the benefit of the past season's experience, the charge can be much reduced. The cost will lessen as the number of trees increases. Not a single complaint was made, however, upon the rate of ten cents per

Figure 2.—Spraying in a back-yard orchard by the public sprayer.

tree, as this was very much less than if each owner had done the work himself, with a small outfit.

It was found in Hyattsville, after the spraying was in progress, that many persons were anxious to have their trees treated. Not only fruit trees, but also shade trees, hedges, shrubbery, etc., were treated, when desired. The public sprayer did good work in this locality, affording means for the treatment of many trees that would otherwise have died, or stood as a menace to the neighborhood by distributing the pest to other trees. Cuts Nos. 1 and 2 show different views of this sprayer at work.

The outfit established in Talbot county, under the supervision of Mr. J. E. Aaronson, proved equally as successful. The one in Frederick, after two weeks' work, was abandoned, on account of labor conditions.

It is the intention of the Department to establish more of these outfits, as funds will permit, in appropriate localities in Maryland, especially where they can work in small towns and cities. It is believed that the only way in which all citizens can be induced to have their trees sprayed is to furnish means whereby they can have it done. In some cases, where the territory justifies it, the work may be conducted in both Fall and Spring.

THE PEACH LECANIUM OR TERRAPIN SCALE.

Eulecanium nigro-fasciatum, Perg.

By

A. B. Gahan.

This scale was for many years confounded by American entomologists with the European scale, *Eulecanium persicae,* Fabr., and for that reason the early history of the species is badly confused. It was not until 1898 that Mr. Theo. Pergande first established its separate identity, and gave to the new species the name of *Eulecanium nigro-fasciatum.* He established the fact that it was a native of the Eastern United States, and located its original habitat in the region between New York and Washington, D. C. The pest is now found in all of the States east of the Mississippi river, and in a number of the Western States as well. Since it is indigenous to Maryland, it is not surprising to find this scale present in all parts of the State in greater or less abundance. It seems, however, to be more prevalent in the mountain districts of the Western part of the State than in the tidewater counties. The majority of the complaints recently received regarding it have come from Washington and Frederick counties, but its presence has been noted in several other localities, particularly Kent and Prince George's counties.

Although nominally an enemy of the peach, the Terrapin scale does not confine itself to that fruit tree, but is likewise injurious to the maple and plum, and it is said to also infest apple, linden, birch, sycamore, poplar and blueberry. No extended survey of the State has been made to determine the relative importance as a host plant of these different species of trees, but the greater part of the damage done by it is undoubtedly to peach orchards. One instance of severe injury to maple shade trees came to our notice the past season, through correspondence with Mr. John Diehl, of Johnsville, Frederick county, who sent species of the scale on red maple, and reported that the trees were being badly injured. A severe infestation of plum trees was observed in a plum orchard on the College farm in 1906, and specimens on plum are occasionally received from correspondents for identification. Beyond a few scattered specimens on an apple tree that stood in the midst of a very badly infested peach orchard, the writer has never observed this scale upon other hosts than the plum, peach and maple, and it is probable that these are the only hosts of any importance in this State.

NATURE OF THE INJURY.

The injury caused by this scale is different in some respects from that caused by the San Jose or Chinese scale, and most other similar

pests. While the drain upon the strength of the tree caused by the sucking up of its sap by the insects cannot be otherwise than detrimental, it is, nevertheless, rarely ever sufficient to cause the death of the tree. The young growth is frequently stunted, and sometimes killed. The scale infests chiefly the twigs and smaller branches of trees that are full grown, leaving the trunk and larger limbs practically unmolested, and this fact may account, to some extent, for the escape

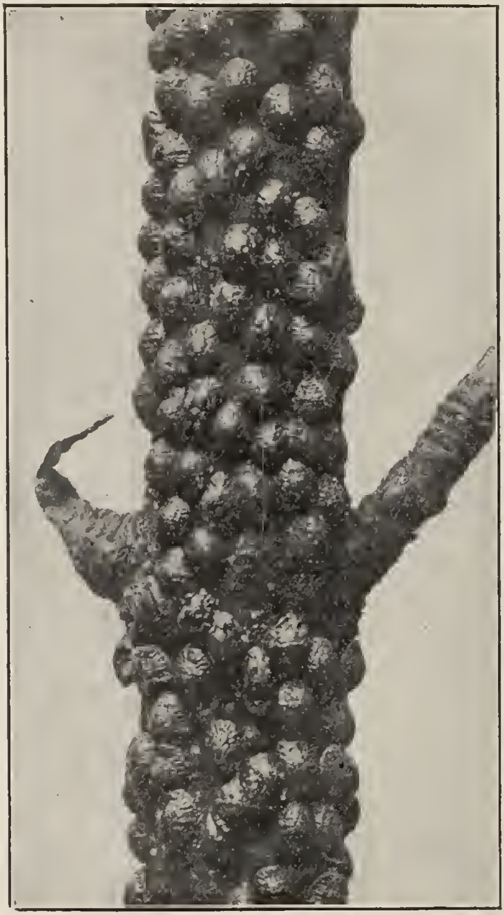

Figure 3.—Adult females of the Terrapin Scale on a peach twig. After Sanders, U. S. Dept. of Agri., Bureau of Ent.; Cir. Bul. 88.

of the tree from destruction, enough vigor being retained in the trunk and large branches to overcome the loss from the twigs.

The principal loss then to the orchardists from this pest is through the damaging of the fruit. Large quantities of honey-dew are secreted by the female insects, and this collects upon the leaves, twigs and fruit,

covering them with a sticky coating. This honey-dew acts as host for a black fungus, which renders the fruit from an infested tree dirty and repulsive-looking, and consequently unsalable. So plentiful is this fungus growth at times that it gives the whole trees the appearance of having been sprinkled with soot.

DESCRIPTION AND LIFE HISTORY.

The Terrapin scale gets its popular name from its shape, which is not unlike that of a small terrapin. It hibernates as an immature female, and is most often seen in that form. At this stage it is a small, hemispherical object, about two mm. in length, and slightly less in width, with an orange red patch on the back, and darker streaks radiating toward the sides. The back is slightly flattened, and the sides more or less corrugated or ridged. The size increases and the color changes as the females advance in age, so that when full grown they are about three mm. in length, of a nearly uniform reddish-brown color, very convex, and slightly flaring at the sides. After oviposition the empty scale often becomes grayish.

The hibernating females attain full growth, and commence ovipositing in the early part of May. The eggs are deposited beneath the mother scale, her body gradually shrinking, as the process of ovipositing goes on, until when ovipositing is finished, only the hard scale covering filled with eggs remains. The eggs begin hatchng about the first of June, and from that time on until the middle of August young crawling scale can be found upon an infested tree on every bright day. The young when hatched are very small, flat, quite active creatures, which soon find their way to the leaves, where they settle along the mid-rib and veins upon either surface. They remain on the leaves for six to eight weeks. The males then emerge winged, and the females, after being fertilized, go back to the twigs and small branches, along the undersides of which they attach themselves. As seen upon the leaves the young scales are considerably longer than broad, flat and semi-transparent, appearing as greenish-white spots. After their migration to the twigs, the females continue to feed and grow until cold weather, at which time they are about half grown. They then become dormant until Spring, when they complete their growth and deposit eggs, as already described.

PARASITES.

This scale insect is attacked by both insect and fungus parasites of great efficiency, and it is because of these that the scale has not become a worse pest than it has. The two most effective enemies seem to be a small Chalcid fly, and a fungus disease closely related to, if not identical with *Cordyceps clavulata*. The work of the Chalcid is apparent wherever the scale is found in this State. Examination of an infested tree rarely failed to show a large number of empty scale-shells,

each with a tiny round hole in the back, showing where the parasite had come out. Some cases were observed in which it was estimated that forty to fifty per cent. of the scale had been parasitized.

Figure 4.—Young Terrapin scales on the leaves and showing infestation with entomogenous fungus. (Original).

The fungus parasite was first observed attacking the scale on the plum trees before mentioned as occurring on the College farm. These trees were five in number, all badly infested, and were being closely watched for the purpose of taking notes on the life history of the scale. In the early part of July, 1906, a number of scales on one of the trees were observed encircled by a ring of whitish mould, and upon examination were found to be dead. Subsequent observations revealed the fact that the disease was spreading, and it was carefully watched. Within three weeks it had attacked practically every scale, both young and old, on the tree upon which it originally appeared, and was spreading to the other trees. By the middle of September some scale on each of the five infested trees were diseased, and when cold weather

set in it was impossible to find a scale on any of them that was not diseased. A careful examination the following spring, of all the five formerly infested trees, as well as the trees contiguous to them in the orchard, failed to discover a single live specimen of scale upon any of them. All but a few scattering individuals had dropped off, leaving the bark of the trees clean, except for a ring of the mould where each

Figure 5.—Appearance on peach twigs, of adult Terrapin scales attacked by entomogenous fungus. (Original).

scale had been. The accompanying cuts illustrate very clearly the appearance both of the young on the leaves and the adults on the twigs when attacked by this fungus.

The value of such an entomogenous fungus can hardly be estimated, and peach growers would do well to be on the watch for it, and

give it protection where found. The writer is unable to say whether spraying with insecticides for the scale will destroy the fungus, but would advise allowing trees whereon the disease makes its appearance to go unsprayed, rather than run the risk of destroying so beneficial a parasite.

EXPERIMENTS.

It was possible to find record of but little work that had ever been done with insecticides for the control of the Terrapin scale. Practically all writers who have undertaken to prescribe a remedy at all heretofore, have recommended the use of ten per cent. kerosene emulsion applied as a summer spray, or twenty per cent. used during the dormant season. The lime sulfur wash has been almost universally branded as a failure as a remedy for it. In view of the fact that the pest has become one of considerable economic importance in the State, and as there seemed to be very little definite information concerning insecticides to be used against it, a series of experiments, to determine, if possible, the most satisfactory means of combatting it, was undertaken. Accordingly, two badly infested peach orchards, comprising about five hundred trees, were selected and treated as follows:

One hundred and seventy-five trees were sprayed March 22, with miscible oil, using one part oil to 22.5 parts water.

Eighty trees sprayed March 22, with miscible oil, using one part oil to fifteen parts water.

Twenty-five trees sprayed April 7, with miscible oil, using one part oil to ten parts water.

Two hundred trees sprayed March 22, with lime sulfur wash, using twenty pounds lime to fifteen pounds sulfur.

Fifteen trees sprayed April 7, with lime sulfur wash, using 20 pounds lime to fifteen pounds sulfur.

Eight trees sprayed August 2, with ten per cent. kerosene emulsion.

Three different proprietary brands of the soluble oils were used (Kiloscale, Scalecide and Soluble Petroleum). As all are much alike, and as the results for each, where the same strengths were used, were practically the same, it is sufficient for the purposes of this bulletin that they be treated as one. Besides being applicable during the dormant season, these oils possess the additional advantage of being easily prepared, and not disagreeable to apply. Results being equal, most growers will prefer to use them rather than the lime sulfur wash or kerosene emulsion.

The lime sulfur wash employed in these experiments was made according to the formula now generally recommended for the San Jose Scale, viz.: Twenty pounds of lime, fifteen pounds of sulfur, and fifty gallons of water. The lime and sulfur cooked in twenty gallons of water for three-quarters of an hour, and then diluted with cold water to fifty gallons, and applied while warm.

The kerosene emulsion was made according to the usual method, and applied the first week in August, after the most of the scale had hatched and settled upon the leaves. The object in this experiment was to test the effect of one spraying in midsummer, as compared to one treatment during the dormant season with the lime sulfur and miscible oil washes. The application was delayed until most of the eggs had hatched, as it was thought that the treatment would then be more effective. This is now believed to have been a mistake, however, as the majority of the eggs had hatched three or four weeks before the spray was applied, and the young were upon the leaves, where many of them were undoubtedly missed by the spray. Had the treatment been given about the first of July it would doubtless have been more successful, since the young scale would then have been more easily reached with the spray, as but few had yet gone to the leaves.

The lime sulfur wash and the miscible oil were applied at the time of year which has proven most satisfactory for the treatment of the San Jose Scale, viz., shortly before the leaves come out in the Spring. The advantages of being able to spray during the dormant season are so patent, and have been so often pointed out, that there is no need to mention them here. Suffice it to say that other things being equal, a spray that can be applied effectively at that time is much to be preferred to one that has to be used in the summer.

The sprayed plats were examined during the summer months, to note their condition, but final notes were not taken until September 21, when the surviving young had all left the leaves, and were settled upon the twigs preparatory to hibernation.

RESULTS.

The results obtained from these experiments were in some cases not as expected, but they are believed to be reasonably accurate. The kerosene emulsion apparently accomplished the least good. The sprayed trees were somewhat less infested than were check trees left untreated, but the improvement was not sufficient to pay for the trouble which the treatment necessitated. As has been already pointed out, the failure of this wash may have been due in part to the lateness of the application, but even had it been applied earlier the probabilities are that the results would not have been equal to those from the Spring applications of the lime sulfur and miscible oils, on account of the difficulty of doing perfect work when the leaves are on the trees. Because of the long-hatching period of the eggs of the insect, it is highly improbable that one midsummer application of kerosene emulsion can be made to rid a tree of this scale.

Contrary to expectations, the trees sprayed with the lime sulfur wash showed great improvement at the time of the final examination. While not entirely free from scale, the numbers of the pest had been so reduced as to leave the trees in good condition. What scale remained were confined to the tips of the branches upon the wood which

had grown since the wash was applied. The examinations of the trees during July and August had shown that the wash had had but slight effect upon the adult females, most of which succeeded in reaching maturity and depositing eggs. In July a great many young scales were observed, not only crawling on the trunk and limbs, but upon the leaves as well. These had disappeared, however, at the time of the final examination, indicating that in the case of this scale, as with the San Jose Scale, the chief benefit derived from the lime sulfur wash is that its presence on the trees during the breeding season prevents the young scale from settling, rather than that the over-wintering females are killed by it.

The most gratifying results, however, were obtained in the use of the miscible oils. In the weaker dilution (one part oil to 22.5 parts water) these preparations gave results about equal to the lime sulfur wash; but on the trees upon which one part of oil to fifteen parts water, and where one part oil to ten parts water, were used the number of scale remaining in September was exceedingly small. Some of the trees were entirely freed of the pest, and all were in good shape. No appreciable difference was apparent between the 1-10 and the 1-15 plats.

In the case of these oils the effect upon the scale is immediate, instead of being delayed, as with the lime sulfur wash, the over--wintering females being killed by the application. It was noticeable that the scales became loosened upon the twigs shortly after the oil was applied, and many of them dropped off before the breeding season began.

CONCLUSIONS.

These experiments, although extending over but one season's work, are sufficiently convincing, it is believed, to warrant the following conclusions being drawn:

1. That one application during the growing season, of kerosene emulsion, while better than no treatment, cannot be relied upon to suppress the terrapin scale in a badly infested orchard.

2. That the lime sulfur wash applied in the springtime, just before the leaves start, is a fairly efficient remedy.

3. That the proprietary preparations, or miscible oils (Kiloscale, Scalecide and Soluble Petroleum), applied in the proportions of one part oil to fifteen parts water, or stronger, constitute a satisfactory remedy for this pest.

The thanks of the Department, and of the writer, are due and are hereby extended to Mr. A. L. Towson, Smithsburg, Md., and Mr. Samuel King, Mapleville, Md., for their co-operation in the carrying out of the experiments by the loan of their respective orchards for the purpose, and the furnishing of men and apparatus for doing the work.

THE MARYLAND

AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 124. DECEMBER, 1907.

STRAWBERRIES.

By C. P. Close, W. R. Ballard and T. H. White.

INTRODUCTION.

Inasmuch as this Station has published nothing on strawberries since bulletin No. 33 appeared, in 1895, we are justified in including in this bulletin minute descriptions of many old varieties which have been grown for several years in the testing beds. The descriptions were all made from fruits of the 1907 crop. The yields are given in tabular form for the years 1905, 1906 and 1907. Each variety was allowed 70 square feet of row space, and the yield per acre is computed from the actual yield of this amount of land.

Usually the beds are fruited only one year, but the 1905 beds were kept for a second crop. When the young plants for new beds are taken from the Station plantation they are set out in early spring and are well cared for during the season. It often happens that plants sent here for testing arrive late in the spring and before they get well established are injured by drought and never recover sufficiently to give a full yield of fruit. Such was the case in 1906 with some varieties which produced very small yields in 1907. In early winter the plants are mulched with straw or coarse stable manure to protect them from the heaving effect of frost.

The soil at the Station is not well adapted to the testing of strawberries; it is a rather heavy, cold, clay loam, very uneven in texture and quality. This unevenness in quality no doubt accounts for some of the great differences in yield of varieties side by side.

CLIMATIC CONDITIONS.

The early part of the season of 1905 was marked by a drought which was very severe on young beds just set, but not so injurious to the fruiting beds. These young beds were not only somewhat weakened in 1905, but in May, 1906, when they were in bloom a very heavy freeze killed most of the blossoms and reduced the crop to almost nothing.

The terminal fruit buds on the fruiting beds for 1907 were killed by the severely cold weather of February when the thermometer registered 15 degrees below zero. The season of 1907 was cold, damp and cloudy, so that the berries did not ripen as early as usual, but continued ripening over a longer season than customary. Under such climatic conditions the fruit could not develop its highest quality, and this must be taken into consideration in reading the descriptions which follow, because in an ordinary season the quality would undoubtedly be much better than it was in 1907.

RECOMMENDING VARIETIES.

The strawberry is so peculiar in its adaptability to soil and climatic environment that it is not wise to recommend varieties except with restrictions. A variety will succeed admirably in one locality and fail dismally a few miles distant. It is well to plant principally the varieties which do well in the neighborhood and test new varieties which seem to be promising. The Gandy appears to be an exception as it usually does well on most low, moist, black, sandy loams. The Station soil is so different from that of the strawberry sections of the State that the behavior of a variety here is no criterion of what it will do elsewhere. Considering this cool and damp season only, such varieties as Yant, New York, Armstrong and Dole might safely be mentioned as most promising, yet when they were tested here a few years ago they were discarded as unsatisfactory. The Togo Seedling No. 2, which produced 12,498 quarts per acre in 1905, has done very poorly since. The best practice is to watch varieties in one's neighborhood and grow principally those which succeed best. It is also desirable to try promising new varieties in a small way, and thus determine which ones are likely to be adapted to any section.

SELECTING, PREPARING AND IMPROVING THE SOIL.

A sandy loam is best for the strawberry, but heavier loams may be used if necessary. Freshly plowed sod should be avoided because of the various insects especially cut worms, white grubs and wire worms, which it contains. It is well, also, to avoid corn and melon fields which have been infested with aphids, because the ants which associate with corn and melon aphids will also associate with strawberry aphids. Thus it is that if the ground is already infested with ants when strawberries are planted the strawberry aphis will spread quickly if it is introduced in any way. Sweet potatoes, round potatoes and tomatoes are good crops to precede strawberries because they require thorough cultivation.

If tomatoes are being grown, crimson clover seed, 20 pounds per acre, should be sown at the last cultivation, so as to have a good cover crop to plow under in the spring. Irish potatoes should be immediately followed by crimson clover seed. It may be too late to sow crimson clover seed after sweet potatoes are dug, and in that case rye, one

bushel per acre, should be used. The object is to get as much green vegetable matter as possible to plow under.

If it is desired to improve very poor land for strawberry growing sow cowpeas, one bushel per acre, in May, plow them under early in August and sow crimson clover seed, 20 pounds per acre; plow this under in the spring and set the strawberries. If some special crop occupies the ground during the summer sow the crimson clover seed as early in August as possible, plow down the crop in May following, sow cowpeas, turn these under perhaps in September and sow rye, plow this down in spring and set the strawberry plants. If stable manure can be procured it may be used most liberally even up to 40 tons per acre before planting tomatoes, round or sweet potatoes, and after these crops more manure or cover crops may be used before strawberries are planted. By following either of these plans large amounts of humus will be added to the soil and humus is just what strawberries delight in and need. New ground is best for strawberries because it is full of humus, but since new ground is not always available it becomes necessary to make old ground resemble it in physical condition and fertility. The soil should be thoroughly worked into a loose and friable condition for receiving the plants in spring.

FERTILIZERS.

The question of fertilizers for strawberries can be discussed only in a general way because so many factors enter in, such as different grades of soil, different degrees of fertility of the soil, different previous treatment and crops, and different seasonal conditions and handling of the fruiting bed.

The 3-9-7 formula (3 per cent. nitrogen, 9 per cent. potash and 7 per cent. phosphoric acid) seems to be a popular one for strawberries, and the amounts of fertilizer in the first formula below are suggested per acre as furnishing enough plant food to comply with the 3-9-7 formula. If the grower wishes to use more than these amounts it might be well to increase all in the same proportion:

Per acre	100 lbs. nitrate of soda, or 75 lbs. sulphate of ammonia, or 250 lbs. cottonseed meal.
	90 lbs. sulphate of potash, or 95 lbs. muriate of potash, or 400 lbs. kainit.
	250 lbs. acid phosphate, or 250 lbs. dissolved bone.

A little variation from the above is:

500 to 1000 lbs. Per acre	500 to 700 lbs. ground fish, bone meal or tankage.
	200 lbs. muriate of potash.
	1,100 to 1,300 lbs. acid phosphate.

Other amounts sometimes used are:

Per acre new beds	200 lbs. muriate of potash. 600 lbs. dissolved S. C. Rock.
Per acre old beds	100 lbs. nitrate of soda. 200 lbs. muriate of potash. 200 lbs. dissolved S. C. Rock.

For new beds the fertilizer should be applied in spring, before the plants are set, either broadcast by wheat drill, or otherwise, or along the rows. In either case, but especially in the latter, the fertilizer must be thoroughly mixed into the soil with the cultivator or it may injure or destroy many of the plants.

If beds are to be kept for second year fruiting the fertilizer should be applied along the rows when they are cleaned up after the first crop is picked.

Nitrate of soda is sometimes used on fruiting beds about blossoming time, being applied along the rows at the rate of 75 to 100 pounds per acre.

SEX IN STRAWBERRIES.

The fact that some varieties have imperfect, pistillate or female blossoms, and others have perfect blossoms which are called staminate, bi-sexual, or male blossoms, and that varieties with imperfect blossoms should be planted next to those with perfect blossoms in order to obtain proper pollination of all blossoms and a good setting of fruit, is well understood. From two to four rows of any imperfect flowered variety should be alternated with from one to four or more rows of a perfect flowered variety blooming at the same time. It is even claimed that perfect flowered varieties will fruit better if planted in alternate sets of rows so as to secure cross pollinaton.

SETTING THE PLANTS.

Set the plants as early in the spring as possible. In Southern Maryland the ground is sometimes prepared in late fall and the planting is done in winter whenever the weather permits. The plants are trimmed for setting by taking off all dead leaves and all except one or two of the live ones, and cutting the roots back to about three inches in length. This root pruning is quickest done with pruning shears or knife removing all of the surplus roots from a bundle of 25 plants at one or two cuts. Keep the plants moist; a bucket containing a little water is handy for this purpose while planting. A spade or broad-bladed dibble is convenient for opening up the soil to receive the plants. The particular point is to place the plants so the crown is just above ground and to press the soil firmly around the roots. The opening made to receive the plant must be entirely closed.

The matted row system is best adapted for commercial purposes. The rows are usually made three and one-half or four feet apart and the plants are set from 15 to 18 inches apart in the row. The width of the matted row depends upon the wishes of the grower, he may have it either wide or narrow. If blossoms appear they should be removed so the plants will put all of their energy into growth.

CULTIVATION.

The ground must be thoroughly cultivated during the entire growing season to keep it loose and friable. This condition of the soil is beneficial in several ways. It allows the air to penetrate the soil which is necessary as roots need air; it retains moisture in the soil by preventing rapid evaporation from the surface; it assists in breaking down plant food which would otherwise remain insoluble and it keeps the ground free from weeds which rob the plants of moisture.

It is not a usual practice to cultivate the fruiting beds in spring, but this ought to be done to loosen up the soil so it will hold more moisture and evaporate less, and thus in case of drought the crop will not suffer so quickly if at all.

MULCHING.

As soon as the ground freezes the plants should be covered with straw, coarse manure, pine needles, sea weed, or something else to prevent frost from heaving out the plants. If the new growth in spring cannot easily work its way up through the mulch it is necessary to remove enough of it so as not to injure the plants. The mulch must be left beneath the plants so as to keep the berries from touching the earth and also to prevent the rain from spattering them with sand and dirt. In fact, even if the winter is not severe enough to require mulching for protection, it should be done anyway to protect the berries from dirt and sand for gritty fruit is a drug on the market.

PICKING AND PACKING THE FRUIT.

Too much emphasis cannot be laid on the care necessary in picking and packing strawberries. The fruit stem should be pinched off carefully without bruising or even pressing on the berry with the hand. Only good fruit should be picked for shipment. The baskets should be well filled so as not to appear slack when they are offered for sale in the market. The 24 and 32 quart crates are by far the best to use as these sizes handle better, carry better, and sell better than larger crates. Above all things use only clean, new crates and baskets, because soiled ones are almost a disgrace to modern berry growing. Aside from the aesthetic feature and the satisfaction of putting good fruit in clean packages, it pays financially to invest in bright new baskets and carriers.

RENEWING OLD BEDS.

As soon as the fruit is gathered it is well to mow the patch and burn it over quickly as soon as dry enough, so as to destroy as much of foul matter, fungous diseases and insects as possible. Then plow between the rows throwing furrows together and cut the rows to about one foot in width. Thin out the remaining plants leaving only the young, vigorous ones, and cultivate the ground level between the rows. Another way is to plow down one-half of the width of each row, cultivate well and let new runners cover it from the remaining half. When enough new plants are established the old portion of the row should be plowed down and cultivated and practically a new plantation will be secured. Cultivation should be continued until the end of the growing season. Ordinarily the strawberry field is plowed up and planted to some other crop after the second year, principally because of the expense of cleaning up an old bed.

If it is desired to grow one's own plants this may be done by planting a few rows extra for this special purpose. The practice is a good one.

MULCHING EXPERIMENTS FROM 1902 TO 1906.

The following table shows at a glance the plan of the tests and the results for each year. Plot 1 was covered with straw in early winter. Plot 2 was mulched with strawy horse manure, 10 tons per acre, at the same time. Plot 3 received commercial fertilizer to equal in amount the plant food in the horse manure on plot 2, but had no protecting mulch applied. The fertilizer was applied when the other plots were mulched. Plot 4 was a check, receiving no mulch.

Table Showing Treatment of Plots and Yields of Fruit Per Acre in 1902, 1903, 1904, 1905 and 1906.

Plots.	1902 qts. per acre	1903 qts. per acre	1904 qts. per acre	1905 qts. per acre	1906 qts. per acre
1. Straw mulch*	3744	3600	2505	1631	1166
2. Strawy horse manure mulch	3020	3066	2287	2310	1324
3. Com'l fertilizer but no mulch	1416	2385	762	1709	....
4. Check	2476	2925	1570	1709	1438

*In 1904 small corn stalks from sowed corn were used instead of straw.

In 1902 the straw mulch plot produced 1,268 quarts per acre more than the check plot, and the strawy manure plot 544 quarts more than the check. These are substantial gains for the mulching work. The commercial fertilizer plot was a surprise in that its yield was 1,060 quarts less per acre than the check plot. Lovett, Glen Mary and Tennessee were the varieties used.

The 1903 results do not show so much gain for the mulching over the check plot, yet the gain for straw mulch was 675 quarts. The commercial fertilizer plot yielded 540 quarts per acre less than the check plot. Glen Mary and Gandy were used this year.

In 1904 the effect of mulching is much better than in 1903. The corn stalk mulch gain is 935 quarts, and the strawy manure mulch gain is 717 quarts over the check, while the loss for the commercial fertilizer plot is 808 quarts per acre.

During the season of 1904 the new bed for 1905 fruiting did not make satisfactory growth, so the 1904 fruiting bed was continued for fruiting in 1905. The results are rather unusual, inasmuch as the straw mulch plot yielded 78 quarts per acre less than the check plot. The strawy manure plot did very well in giving a gain of 601 quarts per acre over the check plot. The commercial fertilizer plot and the check plot yielded equal amounts. Because the commercial fertilizer seemed to cause a reduced yield during three years and did not increase the yield the fourth year compared with the check plot, it was not continued in the 1906 work.

The 1906 crop was badly injured by a drought during blossoming time and a heavy freeze in May, and the yields are unfavorable for the mulched plots. The check plot yielded 272 quarts per acre more than the straw mulch plot and 114 quarts per acre more than the strawy manure mulch. In 1904, 1905 and 1906 the Lovett only was used in this test.

Considering the five seasons the gain in yield of the straw mulch over the check is 2,528 quarts, and the gain for strawy manure mulch over the check is 1,889 quarts. During the four seasons in which the commercial fertilizer was continued the total loss in yield for it was 2,408 quarts compared with the check plot. From these results the straw mulch applied in early winter is most earnestly recommended.

MULCHING EXPERIMENTS IN 1907.

The question of a crabgrass mulch was being discussed and the plan of the experiment was changed to include a crabgrass plot for fruiting in 1907. The Tennessee was the variety used. There were five plots each 20 by 100 feet in size handled as follows:

Plot 1—received no cultivation after August 1, 1906, and the crabgrass was allowed to grow to form a mulch for the plants.

Plot 2—was cultivated until late in the Fall and was mulched with strawy fresh horse manure in early winter.

Plot 3—was handled like plot 2 except that wheat straw was used for a mulch.

Plot 4—was cultivated in the Fall like plots 2 and 3, but the wheat straw mulch was not put on until the Spring of 1907. This mulch was put on to hold moisture in the ground and to protect the fruit from dirt and grit.

Plot 5—check, was cultivated in the Fall like plots 2 and 3, but received no other treatment.

The dates of picking the fruit and the yields in quarts per acre from the five plots follow:

Plot	First Picking	Last Picking	Yield in Quarts Per Acre
1	May 31	June 18	2581
2	June 7	June 24	4946
3	June 7	June 24	6294
4	June 7	June 22	4100
5	June 7	June 22	3289

From these figures it is seen that plot 1, the crabgrass plot, produced ripe fruit a week earlier than any of the other plots, but its yield is 708 quarts less per acre than the check plot and 3,713 quarts per acre less than plot 3 mulched with wheat straw. At ten cents per quart this represents a gain for plot 3 of $371.30 per acre for Fail cultivating and mulching with straw. Plot 2 mulched with strawy manure yielded 1,657 quarts per acre more than the check plot. Plot 3 mulched with straw made a gain of 3,005 quarts per acre over the check and plot 4 which was not mulched until Spring made a gain of 811 quarts over the check. At ten cents per quart plot 3 produced $300.50 more per acre than the check plot and this represents the returns from a small investment in straw mulching.

Comparing the yields of plots 2, 3, 4 and 5 with the crabgrass plot, No. 1, the differences are even more striking. Plot 2 gained 2,365 quarts per acre, plot 3 gained 3,713 quarts, plot 4 gained 1,519 quarts, and plot 5 gained 708 quarts per acre over plot 1. These results indicate that it is most profitable to follow the practice of late cultivation and mulching.

YIELD OF VARIETIES IN TESTING PLOTS.

The following tables give the yield in quarts per acre of the varieties tested at the Experiment Station during 1905, 1906 and 1907. The 1905 bed was held over for second-year fruiting in 1906 and the yields are given in the 1906 column designated "old bed." The varieties are arranged alphabetically according to season of ripening as "early," "mid-season" and "late." The sex of each variety is designated by "S" for staminate or perfect flowers, and "P" for pistillate or imperfect flowers. No further explanation can be given for unevenness of yields than what is mentioned under "climatic conditions."

STRAWBERRY YIELDS IN QUARTS PER ACRE.

Variety			Old Bed	New Bed	
Early	Sex	1905 qts.	1906 qts.	1906 qts.	1907 qts.
Abington	S	....	....	....	3113
August Luther	S	....	....	....	591
Bountiful	S	....	....	....	4045
British Queen	S	816	50	....	2022

Variety	Sex	1905	Old Bed 1906	New Bed 1906	1907
Early		qts.	qts.	qts.	qts.
Cameron	S	3848	2030	816	311
Catherine	P	....	....	....	1991
Climax	S	3168	1182	624	6658
Early Beauty	S	4974	1677	1446	1804
Early Hathaway	S	4232	3366	1134	3236
Elba	S	3440	1014	807	4636
Eleanor	S	....	....	....	498
Excelsior	S	3186	1446	2028	653
Fairfield	S	3972	594	....	1609
Gen. Joe Wheeler	S	....	....	....	4045
Glen Mary	S	4739	2004	1716	6036
Hall No. 2	S	....	...	....	1120
Haverland	P	3576	4488	2616	1929
Heflin Early	P	....	....	....	1836
Hero	S	5407	567	216	1587
Hoffman	S	....	....	....	840
Johnson	S	1002	198	456	591
Kuropatkin	S	7969	3712	2244	4387
Lady Thompson	S	3316	1188	1224	6098
Louis Hubach	P	6534	5643	1464	1338
Mammoth	P	4528	1089	480	1587
May King	S	....	....	....	2551
Michel	S	2376	1240	456	1338
Oak Early	S	....	....	....	2147
Oom Paul	S	2796	312	408	1338
Reliance	S	....	....	....	715
Rio	S	....	....	....	1213
Senator Dunlap	S	....	....	....	1431
Springdale	S	1856	297	528	1609
Stakeley	P	5568	1782	600	3350
Superior	S	....	....	....	3298
Surprise	S	8922	2883	552	6411
Thompson Early	S	3564	1038	....	....
Thompson Earliest	S	3923	2673	792	1369
Thompson 203	S	3267	72	....	622
Thompson 501	S	3625	1732	1440	1462
Thompson 502	S	4343	2004	....	2458
Wild Wonder	S	....	....	....	1307
Yalu	S	2462	594	1104	1431
Mid-season.					
Advance	S	....	....	....	1189
Armstrong	S	....	....	....	3267
Arnout	S	....	....	....	3298
Auto	S	4182	748	216	2053
Beaver	S	....	....	312	1182

Variety Mid-season	Sex	1905 qts.	Old Bed 1906 qts.	New Bed 1906 qts.	1907 qts.
Ben Davis	S	5222	....	96	1376
Brunette	S	....	....	....	311
Bubach	P	4405	2268	696	902
Cardinal	P	....	....	....	3765
Challenge	S	....	....	....	3173
Chellie	S	2660	336	96	342
Cobden Queen	P	....	....	....	5943
E. H. Ekey	S	....	....	....	840
Gandy x Clyde No 1	S	....	....	336	809
Ham	S	....	....	....	1338
Howard	S	....	....	....	3796
Hummer	S	....	....	....	4324
Kansas	P	5247	2844	312	5911
King Philip	S	....	....	....	964
Lovett	S	6336	1584	396	1960
Lyon	P	10840	4248	1512	8992
Marie	P	7932	5022	552	3702
Marsden Perry	S	....	....	....	1836
McKinley	S	....	....	....	1431
New York	S	....	....	....	1396
North Shore	S	....	....	168	280
No. 1—02	S	....	....	408	3049
Parsons	S	6756	2178	1320	4543
Ridgeway	S	....	....	....	1244
Sample	P	4306	3218	1008	5663
Seaford	P	7932	3712	....	3733
Somerset Maid	S	....	....	....	1053
Stella	P	5464	1980	216	1929
Success	S	....	....	....	311
Sutherland	P	4021	3620	588	2613
Tennessee	S	2400	1254	1904	5538
Togo Seedling No. 1	S	3186	48	188	342
Togo Seedling No. 2	S	12498	1422	456	1751
Togo Seedling No. 3	S	3316	490	336	693
Togo Seedling No. 4	S	4836	1238	501	373
Wolverton	S	....	....	....	3732
Yant	S	....	....	72	3920
Late.					
Arizona Everbearing	S	....	....	....	1804
Aroma	S	....	....	....	840
Bismark	S	1881	567	....	2178
Boston Prize	P	....	....	....	1058
Bowman 1 S	S	2984	99	24	1120
Bowman 24 D	P	5593	742	96	2520
Brandywine	S	4233	1358	72	4854

Variety Late	Sex	1905 qts.	Old Bed 1906 qts.	New Bed 1906 qts.	1907 qts.
Buster	P	....	....	....	7280
Commonwealth	S	2846	408	96	1991
Crimson Cluster	S	....	....	....	716
Dayton	S	....	....	....	373
Dixie Belle	P	....	....	....	1735
Dole	P	3564	1089	1224	5009
Enormous	P	3217	1917	456	1804
Gandy	S	1608	1510	336	1866
Isabella	S	1757	831	240	5663
Jessie	S	4504	312	192	1680
Joe	S	3811	740	96	1773
Kittie Rice	P	2982	1326	728	1617
Klondyke	S	3094	168	....	2738
Latest	P	2524	2475	1368	3350
Leaver	S	606	72	120	809
Lester Lovett	S	3910	1683	504	3298
Major Stoessel	S	321	....	....	311
Mark Hanna	P	3564	2722	48	964
Meade	S	....	....	....	2488
Midnight	S	2190	1230	240	3329
Minute Man	P	3811	2030	696	3982
Mrs. M. Hanna	S	1782	545	....	2240
Nettie	P	....	....	....	1866
New Globe	S	....	....	....	3609
New Home	S	....	....	96	1369
Nick Ohmer	S	4158	50	96	1369
Ninety-Six	S	4950	336	48	2022
Olives Pride	S	1881	96	120	622
Pocomoke	S	5556	1653	456	5663
Porto Rico	P	730	....	....	1244
Pride of Cumberland	S	1707	594	600	4169
Salem	S	6410	247	240	4418
Stevens Late Champion	S	....	....	....	1804
Tilghman Favorite	P	....	....	528	4511
Tubbs	S	1670	302	336	2302
Uncle Jim	S	4578	72	144	3609

Ten Best Yielding Varieties.

Quarts per acre in 1905, 1906 and 1907.

Variety.	Sex.	1905 Qts.	Variety.	Sex.	1906 Qts.	Variety.	Sex.	1907 Qts.
Togo Seedling No. 2	S	12,498	Louis Hubach....	P	5,643	Lyon..............	P	8,992
Lyon..............	P	10,840	Marie.............	P	5,022	Buster............	P	7,280
Surprise..........	S	8,922	Haverland.........	P	4,488	Climax............	S	6,658
Kuropatkin........	S	7,969	Lyon..............	P	4,248	Surprise..........	S	6,411
Marie.............	P	7,932	Kuropatkin........	S	3,712	Lady Thompson..	S	6,098
Seaford...........	P	7,932	Seaford...........	P	3,712	Glen Mary.........	S	6,036
Parsons...........	S	6,756	Sutherland........	P	3,620	Cobden Queen....	P	5,943
Louis Hubach....	P	6,534	Ey. Hathaway....	S	3,366	Kansas............	P	5,911
Salem............	S	6,410	Sample............	P	3,218	Isabella..........	S	5,663
Lovett............	S	6,336	Surprise..........	S	2,883	Pocomoke.........	S	5,663
....	...	......	....	...	......	Sample............	P	5,663

Of the ten best yielding varieties Lyon has the best average for three years, but the berries are so small that it is not desirable. The same is true of Kuropatkin and Louis Hubach although one point in favor of these is that they are early in ripening. Climax did well in 1907 only. Buster is very promising, but has had only one year's trial. Togo Seedling No. 2 has yielded poor crops since 1905.

VARIETIES.

The descriptions of varieties are arranged alphabetically so that any one may be easily found. The "S" following the name of a variety means that the variety has "staminate" or "perfect" flowers, and "P" means that it has "pistillate" or "imperfect" flowers. The name enclosed in parenthesis indicates the source of the plants of any variety; thus (W. F. Allen) means that Mr. Allen furnished the plants and (Station Plot) means that the plants were taken from test plots at the Experiment Station the previous year. The three dates given under blooming mean the time of first bloom, full bloom and last bloom, respectively. The two dates under season are the days of first and last pickings of fruit.

Abington, S.—(W. F. Allen). In bloom May 1-10-20; fair stand; plants moderately large and vigorous; leaflets large, dark; little disease; runners not plentiful; flowers perfect; trusses large, moderately erect, many flowered; berry not uniform, slightly ridged, round-conic, rough wedge shaped, blunt, medium to above, dull crimson, slightly pitted; flesh light pink, firm, moderately juicy, mild sub-acid, fair; core white, solid; calyx large, separates easily; seeds many, small. Season, June 4-24; yield 3,113 quarts per acre.

Advance, S.—(W. F. Allen). In bloom April 29-June 6-18; fair stand; plants small, not vigorous; leaflets small, light green; very little disease; runners many; flowers perfect, medium to large; trusses short, not erect, many flowered; berry uniform, slightly necked, long conic to oblong, somewhat flattened at tip, medium size, bright scarlet, slightly pitted; flesh light red, firm, juicy, mild sub-acid, flat, fair; core pink, not solid; calyx medium, separates easily; seeds many, large. Season, June 4-24; yield 1,189 quarts per acre.

Arizona Everbearing, S.—(W. F. Allen). In bloom, May 3-11-18; thin stand; plants small, not vigorous; leaflets medium, dark; little disease; runners few; flowers perfect, medium size; trusses short, bending, many flowered; berry uniform, round-cordate, large, bright scarlet, slightly pitted; flesh light pink, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx large, adherent, diseased; seeds many, large. Season, June 15-24; yield 1,804 quarts per acre.

Armstrong, S.—(W. F. Allen). In bloom April 26-May 8-20; fair stand; plants large, vigorous; leaflets medium, dark; very little disease; runners few; flowers perfect, large; trusses short, erect, many flowered; berry not uniform, round-conic to wedge-shaped, coxcombed, large, bright scarlet to crimson, very slightly pitted; flesh light pink, firm, not juicy, sweet, good; core pink, solid; calyx large, adherent; seeds many, large. Season, June 15-24; yield 3,267 quarts per acre.

Arnouts, S.—(W. F. Allen). In bloom May 2-13-20; fair stand; plants medium, moderately vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, ridged, round-conic, flattened, often double and irregular, very large, bright and dark crimson, slightly pitted; flesh red, firm, juicy, sub-acid, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 4-24; yield 3,298 quarts per acre.

Aroma, S.—(J. G. Harrison & Sons). In bloom May 1-10-20; thin stand; plants small, not vigorous; leaflets large, dark; very little disease; runners plentiful; flowers perfect, large; trusses moderately large, fairly erect, many flowered; berry uniform, conic, wedge-shaped, blunt, medium to large, bright scarlet, pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core white, solid; calyx medium, adherent; seeds many, small. Season, June 4-24; yield 840 quarts per acre. A good variety for home use.

August Luther, S.—(W. F. Allen). In bloom May 1-6-16; thin stand; plants very small, not vigorous; leaflets small, dark; very little disease; runners very few; flowers perfect; trusses short, not erect, many flowered; berry uniform, slightly ridged, conic, medium size, dull crimson, slightly pitted; flesh light red, firm, juicy, sub-acid to acid, fair; core white, solid; calyx medium, persistent; seeds many, large. Season, June 4-17; yield 591 quarts per acre.

Auto, S.—(Station plot). In bloom April 26-May 6-18; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, somewhat necked, slightly ridged, conic, roundish, irregular, flattened, coxcombed, medium to large, crimson, slightly pitted; flesh light red, firm, juicy, mild sub-acid, sweet, good; core pink, solid; calyx large, separates easily; seeds very many, large. Season, June 4-20; yield 2,053 quarts per acre.

Beaver, S.—(Station plot). In bloom May 3-13-18; fair stand; plants moderately large, moderately vigorous; leaflets medium, dark; considerable disease; runners plentiful; flowers perfect, small; trusses small, not many flowered; berry not uniform, slightly necked, round-conic, blunt, medium size, light crimson, slightly pitted; flesh light red, moderately firm, juicy, sub-acid, fair; core solid, light pink; calyx medium, separates easily; seeds many, large. Season, June 7-24; yield 1,182 quarts per acre.

Ben Davis, S.—(Station plot). In bloom April 26-May 6-20; fair stand; plants small, not vigorous; leaflets small, light; little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry uniform, slightly ridged, round-conic, medium size, bright and dark crimson, slightly pitted; flesh light red, firm, juicy, mild sub-acid, sweet, good; core pink, not solid; calyx medium, adherent; seeds many, large. Season, June 4-24; yield 1,376 quarts per acre.

Bismark, S.—(Station plot). In bloom May 6-15-24; rather poor stand; plants not large, not vigorous; leaflets medium, dark; considerable disease; runners not plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, slightly ridged, roundish, wedge-shaped, uneven, cordate, medium to large, dark scarlet, slightly pitted; flesh rich red, not firm, moderately juicy; sub-acid, fair; core solid, pink; calyx medium, adherent; seeds many, large. Season, June 12-24; yield 2,178 quarts per acre.

Boston Prize, P.—(J. G. Harrison & Sons). In bloom May 1-11-18; fair stand; plants large, vigorous; leaflets medium, dark; very little disease; runners not plentiful; flowers imperfect, large; trusses medium large, not erect, many flowered; berry not uniform, slightly ridged, conic, wedge-shaped, medium to large, bright scarlet, pitted; flesh light red, firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium, adherent; seeds many, small. Season, June 14-24; yield 1,058 quarts per acre.

Bountiful, S.—(J. E. Kuhns, Cliffwood, N. J.). In bloom May 1-10-18; fair stand; plants large, vigorous; leaflets moderately large, dark; very little disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry not uniform, ridged, round, flattened

tip, coxcombed, medium to very large, scarlet to light crimson, pitted; flesh light red, firm, not juicy, sub-acid to acid, fair; core pink, solid; calyx medium, persistent; seeds many, large. Season, June 4-24; yield 4,045 quarts per acre. Seedling of Glen Mary probably crossed with Clyde.

Bowman No. 1, S.—(Station plot). In bloom May 2-10-20; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly necked, somewhat ridged, roundish, irregular conic, medium to large, bright and dark crimson, slightly pitted; flesh red, not firm, juicy, mild sub-acid, sweet, fair; core red, solid; calyx medium, adherent; seeds many, large. Season, June 4-24; yield 1,120 quarts per acre.

Bowman 24 D, P.—(Station plot). In bloom May 6-18-22; rather poor stand; plants not large, vigorous; leaflets small, light; very little disease; runners not plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, cordate-conic, large, bright scarlet, slightly pitted; flesh light red, not firm, juicy, mild sub-acid, good; core pink, solid; calyx large, separates easily; seeds many, large. Season, June 12-24; yield 2,520 quarts per acre.

Brandywine, S.—(Station plot). In bloom May 1-14-20; good stand; plants small, not vigorous; leaflets medium large, light; very little disease; runners plentiful; flowers perfect; trusses medium large, erect, many flowered; berry uniform, slightly ridged, round-conic, flattened tip, large, bright dark scarlet, slightly pitted; flesh very bright red, firm, not juicy, sub-acid to acid, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 7-24; yield 4,854 quarts per acre.

British Queen, S.—(Station plot). In bloom May 2-13-20; good stand; plants large, moderately vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect; trusses not large nor erect; berry not uniform, moderately ridged, round-pointed to wedge-shaped, very large, bright crimson, slightly pitted; flesh deep pink, firm, juicy, sweet, good; core solid, pink; calyx large, separates easily; seeds many, medium. Season, June 4-20; yield 2,020 quarts per acre. This is a seedling of the British Queen grown in England.

Brunette, S.—(W. F. Allen). In bloom April 24-May 6-16; poor stand; plants quite small, not vigorous; leaflets small, dark; little disease; runners very few; flowers perfect; trusses short, not erect, many flowered; berry uniform, slightly ridged, conic, medium size, very dark crimson, slightly pitted; flesh light red, firm, not juicy, sub-acid, fair; core white, not solid; calyx medium, persistent; seeds many, large. Season, June 7-17; yield 311 quarts per acre.

Bubach, P.—(Station plot). In bloom May 4-13-20; very poor stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, ridged, conic, irregular wedge-shaped, large, bright crimson, slightly pitted; flesh rich, light red, firm, juicy, sub-acid, fair; core pink, solid; calyx medium, adherent; seeds many, large. Season, June 4-20; yield 902 quarts per acre.

Buster, P.—(W. F. Allen). In bloom May 4-15-20; good stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers imperfect, small to medium; trusses short, not erect, many flowered; berry uniform, round-conic, large, dark scarlet and bright crimson, slightly pitted; flesh reddish pink, not firm, juicy, mild sub-acid, flat; core pink, not solid; calyx medium; seeds many, large. Season, June 7-24; yield 7,280 quarts per acre. Probably good for home markets on account of attractive appearance.

Cameron, S.—(Station plot). In bloom April 24-May 4-18; poor stand; plants small, not vigorous; leaflets small, light; considerable disease; runners few; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, slightly ridged, roundish-cordate, small, light and dark scarlet, very slightly pitted; flesh light pink, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx small, separates easily, diseased; seeds many, large. Season, May 31-June 4; yield 311 quarts per acre. Not worth further testing.

Cardinal, P.—(W. F. Allen). In bloom May 6-15-20; fair stand; plants medium large, moderately vigorous; leaflets medium, dark; very little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, round-conic, large, attractive dark crimson. slightly pitted; flesh red, firm, juicy, mild sub-acid, fair; core red, solid; calyx large, separates easily; seeds many, large. Season, June 17-24; yield 3,765 quarts per acre.

Catherine, P.—(W. F. Allen). In bloom April 26-May 8-18; thin stand; plants large, not vigorous; leaflets small, light; very little disease; runners not plentiful; flowers imperfect; trusses moderately large, erect, many flowered; berry not uniform, ridged, conic, blunt, flattened tip, medium size, bright scarlet, pitted; flesh pink, firm, not juicy, sub-acid to acid, fair; core red, solid; calyx medium to large, persistent; seeds many, large. Season, June 4-24; yield 1,991 quarts per acre.

Challenge, S.—(W. F. Allen). In bloom May 1-10-20; fair stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners plentiful; flowers perfect; trusses short, not erect, many flowered; berry not uniform, ridged, conic, wedge shaped, flat-

tened tip, medium to large, bright scarlet, pitted; flesh bright red, firm, not juicy, mild sub-acid, good; core light pink, solid; calyx medium to large, persistent; seeds many, large. Season, June 7-24; yield 3,173 quarts per acre.

Chellie, S.—(Station plot). In bloom May 6-13-20; very poor stand; plants small, vigorous; leaflets small, dark; very little disease; runners few; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, occasionally necked, round-conic, wedge-shaped, sometimes flattened, large, crimson, slightly pitted; flesh pink, not solid, juicy, mild sub-acid, fair; core pink, solid; calyx large, persistent, diseased; seeds many, large. Season, June 14-24; yield 342 quarts per acre.

Climax, S.—(Station plot). In bloom April 26-May 9-20; good stand; plants large, vigorous; leaflets small, dark; very little disease; runners not plentiful; flowers perfect; trusses large, fairly erect, many flowered; berry not uniform, ridged, round-conic, blunt, medium to large, bright crimson, rather deeply pitted; flesh bright red, firm, juicy, sub-acid to acid, fair; core pink, solid; calyx medium to large, persistent; seeds many, small. Season, May 31-June 24; yield 6,658 quarts per acre.

Cobden Queen, P.—(W. F. Allen). In bloom May 2-13-20; good stand; plants large, vigorous; leaflets medium, light; little disease; runners abundant; flowers imperfect, medium to large; trusses medium, moderately erect, many flowered; berry uniform, round-conic, wedge-shaped, medium to large, attractive bright scarlet, slightly pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, June 4-24; yield 5,943 quarts per acre. Probably good for home market; very productive.

Commonwealth, S.—(Station plot). In bloom May 2-14-22; fair stand; plants medium large, moderately vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect; trusses short, not erect, many flowered; berry not uniform, moderately ridged, irregular, roundish-conic to coxcomb, large, dark crimson, pitted; flesh red, firm, moderately juicy, sub-acid, flat, fair; core solid, light red; calyx large, does not separate easily; seeds many, large. Season, June 4-24; yield 1,991 quarts per acre.

Crimson Cluster, S.—(W. F. Allen). In bloom May 6-18-22; fair stand; plants large, vigorous; leaflets large, dark; little disease; runners plentiful; flowers perfect, moderately large; trusses short, not erect, many flowered; berry uniform, wedge-shaped, blunt, medium to large, bright scarlet to crimson, slightly pitted; flesh red, firm, juicy, sub-acid to acid, sweet, good; core pink, solid; calyx large, adherent, diseased; seeds many, large. Season, June 16-24; yield 715 quarts per acre.

Dayton, S.—(J. G. Harrison & Sons). In bloom April 26-May 6-18; poor stand; plants small, not vigorous; leaflets small, dark; very little disease; runners plentiful; flowers perfect, large; trusses short, not erect, few flowered; berry nearly uniform, sometimes slightly necked, long conic, flattened tip, medium size, bright scarlet; flesh pink, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx small, separates easily; seeds many, large. Season, June 4-20; yield 373 quarts per acre.

Dixie Bell, P.—(W. F. Allen). In bloom May 4-15-20; poor stand; plants small, not vigorous; leaflets small, light; very little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, ridged, irregular roundish, doubled, large, bright and dark scarlet, pitted; flesh light red, not firm, juicy, sub-acid, fair; core red, solid, large berries hollow; calyx large, persistent; seeds many, large. Season, June 17-20; yield 1,735 quarts per acre.

Dole, P.—(Station plot). In bloom April 26-May 8-18; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, wedge-shaped, cordate, large, bright scarlet, pitted; flesh pink, firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium, adherent, considerably diseased; seeds many, large. Season, June 4-24; yield 5,009 quarts per acre. Especially good for home use.

Early Beauty, S.—(Station plot). In bloom April 24-May 6-14; good stand; plants small, not vigorous; leaflets small, light; considerable disease; runners plentiful; flowers perfect, small to medium; trusses short, not erect, many flowered; berry uniform, round, cordate, small, rich crimson, slightly pitted; flesh dark red, not firm, juicy, pleasant sub-acid, good; core red, nearly solid; calyx small, separates easily; seeds many, small. Season, June 4-17; yield 1,804 quarts per acre.

Early Hathaway, S.—(Station plot). In bloom April 24-May 3-18; good stand; plants not large nor vigorous; leaflets small, dark; little disease; runners not plentiful; flowers perfect; trusses short, bending, many flowered; berry uniform, conic, medium size, bright scarlet, slightly pitted; flesh pink, firm, juicy, sub-acid to acid, rather flat, fair; core pink, solid; calyx medium, separates easily. Season, May 31-June 20; yield 3,236 quarts per acre.

E. H. Ekey, S.—(J. G. Harrison & Sons). In bloom May 1-10-18; fair stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry uniform, slightly necked, conic,

oblong, large, bright scarlet, slightly pitted; flesh red, not firm, juicy, mild sub-acid, fair; core red, solid; calyx very large, separates easily; seeds many, large. Season, June 4-20; yield 840 quarts per acre.

Elba, S.—(Station plot). In bloom April 20-May 3-18; good stand; plants large and vigorous; leaflets medium to large, moderately dark; little disease; runners abundant; flowers perfect; trusses short, many flowered; berry uniform, long conic, medium size, bright scarlet, pitted; flesh whitish pink, rather soft, juicy, sweet to sub-acid, good; core solid, pink; calyx medium, does not separate easily; seeds not many, large. Season, May 31-June 17; yield 4,636 quarts per acre.

Eleanor, S.—(J. G. Harrison & Sons). In bloom April 26-May 6-18; poor stand; plants small, not vigorous; leaflets large, dark; no disease; runners not plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry uniform, round-conic, medium size; dull crimson, slightly pitted; flesh light red, firm, jucy, mild sub-acid, good; core pink, solid; calyx medium, persistent; seeds many, large. Season, May 31-June 17; yield 498 quarts per acre.

Enormous, P.—(Station plot). In bloom April 27-May 8-22; rather poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, round-conic, wedge-shaped, large, bright dark crimson, slightly pitted; flesh light red, firm, juicy, sub-acid, fair; core pink, solid; calyx large, separates easily; seeds many, small. Season, June 12-24; yield 1,804 quarts per acre.

Excelsior, S.—(Station plot). In bloom April 26-May 6-18; fair stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, small to medium; trusses short, not erect, many flowered; berry uniform, roundish, oval, small to medium, rich crimson, slightly pitted; flesh dark red, not firm, juicy, mild sub-acid, fair; core red, nearly solid; calyx small, separates easily; seeds many, small. Season, May 31-June 17; yield 653 quarts per acre.

Fairfield, S.—(Station plot). In bloom April 26-May 6-20; good stand; plants not large, not vigorous; leaflets small, light green; little disease; runners not plentiful; flowers perfect, medium; trusses short, not erect, few flowered; berry not uniform, necked, conic, cordate, oblong, medium size, bright scarlet, slightly pitted; flesh red, not firm, juicy, mild sub-acid, sweet, fair; core red, solid; calyx small, separates easily; seeds many, large. Season, May 31-June 20; yield 1,609 quarts per acre.

Gandy x Clyde, No. 1, S.—(Station plot). In bloom May 1-13-18; poor stand; plants small, not vigorous; leaflets small, dark; very little disease; runners few; flowers perfect; trusses short, moderately

erect, many flowered; berry uniform, conic, round, blunt, flattened tip, large, bright light scarlet, pitted; flesh light pink, not firm, not juicy, mild sub-acid, fair; core white, solid; calyx medium, separates easily; seeds many, large. Season, June 7-20; yield 809 quarts per acre.

GEN. JOE WHEELER, S.—(W. F. Allen). In bloom April 26-May 8-24; good stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry uniform, slightly necked, conic, pointed, medium size, dark scarlet, slightly pitted; flesh light, not firm, juicy, sub-acid, flat, fair; core red, solid; calyx medium, separates easily; seeds many, small. Season, May 31-June 20; yield 4,045 quarts per acre.

GLEN MARY, S.—(Station plot). In bloom April 26-May 6-20; fair stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners very few; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, roundish, irregular conic, medium to large, bright and dark scarlet, deeply pitted; flesh rich red, not firm, juicy, mild sub-acid, good; core red, solid; calyx large, adherent, diseased; seeds many, large. Season, June 4-24; yield 6,036 quarts per acre. Good for home use.

HALL NO. 2, S.—(J. K. Hall, Marion Station, Md.). In bloom April 26-May 6-20; thin stand; plants small, not vigorous; leaflets large, dark; little disease; runners plentiful; flowers perfect, large; trusses large, not erect, many flowered; berry uniform, round-conic, medium size, dark crimson, deeply pitted; flesh pink, very firm, not juicy, sub-acid, fair; core white, not solid; calyx medium, adherent; seeds many, small. Season, May 31-June 17; yield 1,120 quarts per acre.

HAM, S.—(W. F. Allen). In bloom May 4-13-20; good stand; plants small, not vigorous; leaflets medium, dark; considerable disease; runners not plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, conic, irregular, oval, coxcombed, medium to large, very dark crimson, very slightly pitted; flesh, dark red, not firm, not juicy, pleasant, sweet, good; core red, solid; calyx medium, adherent; seeds many, greenish, prominent, very large. Season, June 4-24; yield 1,338 quarts per acre.

HAVERLAND, P.—(Station plot, Kellogg's stock). In bloom April 29-May 6-20; poor stand; plants small, not vigorous; leaflets small, dark; very little disease; runners not plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, necked, long conic, medium size, bright scarlet, slightly pitted; flesh bright red, not firm, juicy, flat sub-acid, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, May 31-24; yield 1,929 quarts per acre.

HEFLIN EARLY, P.—(W. F. Allen). In bloom April 26-May 4-16; fair stand; plants small, not vigorous; leaflets medium, light green; very little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, very slightly necked, somewhat ridged, conic, cordate, sometimes flattened, medium to large, bright scarlet, pitted; flesh light red, not firm, juicy, sub-acid, flat, fair; core pink, not solid; calyx large, adherent; seeds many, large. Season, May 31-June 20; yield 1,836 quarts per acre.

HERO, S.—(Station plot). In bloom May 2-11-22; poor stand; plants not large, moderately vigorous; leaflets medium, dark; very little disease; runners few; flowers perfect; trusses short, bending, many flowered; berry uniform, conic, tip flattened, large, bright dark scarlet, very slightly pitted; flesh bright red, moderately firm, juicy, mild sub-acid, fair; core red, soft; calyx medium, separates fairly easily; seeds many, large. Season, May 31-June 24; yield 1,587 quarts per acre.

HOFFMAN, S.—(W. F. Allen). In bloom April 26-May 6-16; poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry uniform, round-conic, small to medium, crimson, deeply pitted; flesh bright red, firm, not juicy, sub-acid to acid, fair; core pink, solid; calyx medium, persistent; seeds many, large. Season, June 4-17; yield 840 quarts per acre.

HOWARD, S.—(W. F. Allen). In bloom May 6-18-22; fair stand; plants large, vigorous; leaflets medium, dark; considerable disease; runners plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not uniform, ridged, round, slightly conical, somewhat flattened, large, scarlet, slightly pitted; flesh light red, firm, not juicy. mild sub-acid, good; core pink, solid; calyx large, separates easily; seeds many, large. Season, June 10-24; yield 3,796 quarts per acre.

HUMMER, S.—(W. F. Allen). In bloom May 1-10-18; good stand; plants medium large, vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, ridged, roundish, irregular, pointed, wedge-shaped, blunt, large, light bright crimson, slightly pitted; flesh light red, firm, not juicy, pleasant mild sub-acid, good; core red, solid; calyx large, separates easily; seeds many, large. Season, June 4-20; yield 4,324 quarts per acre.

ISABELLA, S.—(Station plot). In bloom May 4-15-24; good stand; plants not large, moderately vigorous; leaflets small, light green; little disease; runners abundant; flowers perfect; trusses small, not erect, many flowered; berry uniform, ridged, wedge-shaped, large, bright crimson, slightly pitted; flesh bright red, firm, moderately

juicy, sub-acid to acid, fair; core light pink, solid; calyx large, does not separate easily; seeds very many, large. Season, May 31-June 24; yield 5,663 quarts per acre.

JERRY RUSK, S.—(H. L. Hutt, Guelph, Canada). In bloom May 1-10-20; the plants were received so late in the season that only a very poor stand was secured; plants small, not vigorous; leaflets medium, dark; little disease; runners very few; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, round, wedge-shaped, blunt, medium to large, crimson, pitted; flesh pinkish red, firm, juicy, sub-acid, fair; core white, solid; calyx medium, persistent; seeds many, large; only a few berries were produced.

JESSIE, S.—(Station plot). In bloom May 1-10-20; good stand; plants small, fairly vigorous; leaflets moderately large, dark; little disease; runners few; flowers perfect; trusses large, erect, many flowered; berry uniform, round-conic, blunt, flattened tip, medium to large, bright scarlet, pitted; flesh bright dark red, not firm, not juicy, mild sub-acid, flat, fair; core pink, not solid; calyx medium; seeds many, large. Season, June 7-24; yield 1,680 quarts per acre.

JOE, S.—(Station plot). In bloom May 1-10-24; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, irregular, round-conic, flattened, medium to large, bright and dark crimson, slightly pitted; flesh light red, firm, juicy, mild sub-acid, sweet, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, June 4-24; yield 1,773 quarts per acre.

JOHNSON, S.—(Station plot). In bloom April 26-May 4-16; fair stand, plants small, not vigorous; leaflets small, dark; very little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, necked, round-conic, small, dull scarlet, slightly pitted; flesh red, not firm, not juicy, mild sub-acid, sweet, musky, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, May 31-June 20; yield 591 quarts per acre.

KANSAS, P.—(Station plot). In bloom May 6-15-18; good stand; plants large, vigorous; leaflets medium, dark; considerable disease; runners abundant; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, ridged, round, wedge-shaped, blunt, large, bright scarlet and crimson, slightly pitted; flesh light red, firm, juicy, pleasant sub-acid, good; core pink, solid; calyx large, persistent; seeds many, large. Season, June 10-24; yield 5,911 quarts per acre.

King Philip, S.—(J. G. Harrison & Sons). In bloom April 26-May 18-24; fair stand; plants large, vigorous; leaflets large, dark; considerable disease; runners plentiful; flowers perfect; trusses large, not erect, many flowered; berry not uniform, roundish, irregular, wedge-shaped, large, bright scarlet, pitted; flesh pink, firm, juicy, sub-acid, sweet, good; core pink, solid; calyx large, diseased, separates easily; seeds many, large. Season, June 14-24; yield 964 quarts per acre.

Kittie Rice, P.—(Station plot). In bloom May 4-15-20; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, round-conic, flattened, large, bright crimson, slightly pitted; flesh red, firm, juicy, sub-acid, fair; core pink, solid; calyx large, persistent; seeds many, large. Season, June 16-24; yield 1,617 quarts per acre.

Kuropatkin, S.—(William Belt x T. W. Matthews, Station plot). In bloom April 24-May 3-18; good stand; plants medium, moderately vigorous; leaflets medium, dark; little disease; runners abundant; flowers perfect; trusses short, erect, many flowered; berry uniform, very slightly ridged, round-conic, tip slightly flattened, below medium, bright scarlet to light crimson, slightly pitted; flesh red, moderately firm, moderately juicy, sub-acid to sweet, fair; core not solid; calyx medum, does not separate easily; seeds very many, small. Season, May 31-June 17; yield 4,387 quarts per acre.

Lady Thompson, S.—(Station plot). In bloom May 1-14-22; fair stand; plants large, vigorous; leaflets large, moderately dark; little disease; runners plentiful; flowers perfect; trusses large, erect, many flowered; berry uniform, conic, flattened tip, medium size, bright scarlet, pitted; flesh light red, firm, juicy, sub-acid to acid, fair; core white, solid; calyx medium, fairly persistent; seeds many, large. Season, May 31-June 24; yield 6,098 quarts per acre.

Latest, P.—(Station plot). In bloom May 4-10-20; fair stand; plants not large, not vigorous; leaflets medium, dark; little disease; runners very few; flowers imperfect, medium size; trusses short, erect, many flowered; berry uniform, slightly ridged, conic, wedge-shaped, flattened, medium to large, scarlet, pitted; flesh light pink, not firm, juicy, pleasant mild sub-acid, sweet, good; core white, solid; calyx large, adherent; seeds many, large. Season, June 12-24; yield 3,350 quarts per acre.

Leaver, S.—(Station plot). In bloom May 4-15-20; fair stand; plants small, not vigorous; leaflets medium, dark; considerable disease; runners few; flowers perfect, small to medium; trusses short, not

erect, many flowered; berry uniform, roundish, restricted point, medium to large, dull crimson, slightly pitted; flesh light red, not firm, juicy, pleasant mild sub-acid, good; core pink, not solid; calyx medium, separates easily, diseased; seeds many, large. Season, June 17-24; yield 809 quarts per acre.

LOUIS HUBACH, P.—(Station plot). In bloom April 26-May 4-16; rather poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers imperfect, small to medium; trusses short, erect, many flowered; berry uniform, round, conic, small, dull crimson, slightly pitted; flesh red, firm, juicy, sub-acid to acid, fair; core red, solid; calyx medium, adherent; seeds many, large. Season, May 31-June 20; yield 1,338 quarts per acre.

LOVETT, S.—(Station plot, Kellogg's stock). In bloom May 4-15-20; thin stand; plants small, not vigorous; leaflets small, dark; little disease; runners not plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not uniform, slightly ridged, round-conic, wedge-shaped, medium to large, dark crimson, slightly pitted; flesh a good red, firm, juicy, acid, flat, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 4-24; yield 1,960 quarts per acre.

LYON, P.—(Station plot). In bloom May 2-13-20; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, round-conic, wedge-shaped, medium, very attractive, light and dark crimson, slightly pitted; flesh bright red, firm, juicy, mild sub-acid, flat; core red; solid; calyx medium, separates easily; seeds many, large. Season, May 31-June 24; yield 8,992 quarts per acre. Very productive, but berries are not large.

MAJOR STOESSEL, S.—(Seedling of Gandy x Clyde, Station plot). In bloom May 4-13-20; rather poor stand; plants small, not vigorous; leaflets medium, dark; little disease; runners few; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, round, blunt, very large, bright crimson, slightly pitted; flesh light bright red, firm, not juicy, pleasant sub-acid, fair; core red, solid; calyx medium, persistent; seeds many, large. Season, June 14-20; yield 311 quarts per acre.

MAMMOTH, P.—(Station plot). In bloom May 4-13-16; fair stand (hills); plants large, vigorous; leaflets medium, dark; very little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, irregular, roundish, coxcombed, very large, attractive bright and dark crimson,

slightly pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 14-24; yield 1.587 quarts per acre. Especially good for local trade.

MAMMOTH CLUSTER, S.—(H. L. Hutt). In bloom May 1-10-20; very few plants, received very late in season; plants small, not vigorous; leaflets small, dark; little disease; runners few; trusses short, not erect, many flowered; berry not uniform, roundish, oblong, medium size, very dark crimson, slightly pitted; flesh dark red, not firm, juicy, very mild sub-acid, fair; core red, solid; calyx small, separates easily, badly diseased; seeds many, small; very few berries produced. Season, June 10-20.

MARIE, P.—(Station plot). In bloom May 4-15-22; fair stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, round, irregular, cordate, medium to large, dull dark scarlet, slightly pitted; flesh red, not firm, juicy, mild sub-acid, fair; core red, solid; calyx large, persistent; seeds many, small. Season, June 4-24; yield 3,702 quarts per acre.

MARK HANNA, P.—(Station plot). In bloom May 6-18-22; poor stand; plants large, not vigorous; leaflets small, dark; very little disease; runners none or few; flowers imperfect, medium; trusses short, not erect, many flowered; berry uniform, slightly ridged, uneven conic to wedge-shaped, medium to large, light and dark crimson, slightly pitted; flesh rich red, not firm, juicy, acid to sub-acid, fair; core pink, solid; calyx large, adherent; seeds many, small. Season, June 14-20; yield 964 quarts per acre.

MARSDEN PERRY, S.—(W. F. Allen). In bloom April 26-May 7-20; fair stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners few; flowers perfect; trusses short, erect, many flowered; berry uniform, conic, flattened tip, medium size, dull crimson, pitted; flesh light red, not firm, not juicy, sub-acid, fair; core pink, not solid; calyx medium, separates easily; seeds many, large. Season, June 7-17; yield 1,836 quarts per acre.

MAY KING, S.—(W. F. Allen). In bloom May 1-13-20; fair stand; plants large, vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect; trusses short, erect, many flowered; berry uniform, round-conic, medium size, bright scarlet, pitted; flesh light red, firm, juicy, sub-acid to acid, fair; core white, solid; calyx medium, persistent; seeds many, large. Season, June 4-20; yield 2,551 quarts per acre.

MCKINLEY, S.—(J. G. Harrison & Sons). In bloom April 26-May 6-18; fair stand; plants large, vigorous; leaflets large, dark; considerable disease; runners few; flowers perfect; trusses short, not

erect, many flowered; berry not uniform, slightly ridged, round-conic, flattened tips, medium to large, bright scarlet to crimson, slightly pitted; flesh white, firm, not juicy, mild sub-acid, fair; core pink, not solid; calyx medium, adherent; seeds many, large. Season, June 7-20; yield 1,431 quarts per acre.

Meade, S.—(W. F. Allen). In bloom April 27-May 8-18; fair stand; plants large, vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, roundish, blunt, large, attractive scarlet, slightly pitted; flesh light red, firm, juicy, pleasant mild sub-acid, good; core red, solid; calyx large, separates easily; seeds many, large. Season, June 15-24; yield 2,488 quarts per acre.

Michel, S.—(Station plot). In bloom April 24-May 4-14; good stand; plants small, not vigorous; leaflets small, dark; much disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, necked, round-pointed, small, bright scarlet, slightly pitted; flesh light pink, not firm, juicy, mild sub-acid, sweet, good; core pink, solid; calyx medium, separates easily; seeds many, large. Season, May 31-June 17; yield 1,338 quarts per acre.

Midnight, S.—(Station plot). In bloom May 1-15-26; good stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners plentiful; flowers perfect, medium; trusses short, not many flowered; berry not uniform, conic, flattened, coxcombed, large, bright light crimson, slightly pitted; flesh white, pleasant sub-acid, sweet, good; core white, solid; calyx medium, persistent, seeds many, large. Season, June 12-24; yield 3,329 quarts per acre.

Minute Man, P.—(Station plot). In bloom May 2-13-18; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners not plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, roundish, slightly conic, flattened tip, large, attractive bright dark scarlet, slightly pitted; flesh light red, not firm, not juicy, mild sub-acid, fair; core red, solid; calyx large, persistent; seeds many, large. Season, June 10-24; yield 3,982 quarts per acre. One of the most attractive and extra good for home market.

Mrs. Mark Hanna, S.—(Station plot). In bloom May 2-11-20; fair stand; plants large, vigorous; leaflets medium, dark; little disease; runners plentiful; flowers perfect, medium to large; trusses large, not erect, many flowered; berry uniform, slightly ridged, short conic, medium to large, bright crimson, slightly pitted; flesh light red, firm, juicy, insipid, sub-acid, fair; core pink, solid; calyx medium, separates easily, diseased; seeds many, large. Season, June 12-24; yield 2,240 quarts per acre.

New Globe, S.—(J. G. Harrison & Sons). In bloom April 27-May 8-16; fairly good stand; plants large, vigorous; leaflets medium, dark; considerable disease; runners plentiful; flowers perfect, medium; trusses large, moderately erect, many flowered; berry not uniform, conic, roundish, irregular, large, dark scarlet and bright crimson, slightly pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium to large, separates easily; seeds many, large. Season, June 8-24; yield 3,609 quarts per acre.

New Home, S.—(Station plot). In bloom May 8-18-26; fair stand; plants small, moderately vigorous; leaflets small, light green; little disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry not uniform, somewhat ridged, round-conic, flattened, often blunt, very large, crimson, slightly pitted; flesh red, firm, juicy, sub-acid, fair; core pink, solid; calyx large, separates easily; seeds many, large. Season, June 16-24; yield 1,369 quarts per acre.

New York, S.—(J. G. Harrison & Sons). In bloom April 29-May 6-16; fair stand; plants large, vigorous; leaflets large, dark; very little disease; runners not plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not uniform, slightly ridged, conic, flattened tip, coxcombed, medium to large, bright and dark scarlet, pitted; flesh pink, firm, not juicy, mild sub-acid, good; core pink, not solid; calyx large, adherent; seeds many, large. Season, June 4-17; yield 1,369 quarts per acre.

Nick Ohmer, S.—(Station plot). In bloom May 1-13-22; fair stand; plant large, vigorous; leaflets medium, dark; little disease; runners few; flowers perfect, medium to large; trusses large, erect, many flowered; berry uniform, slightly ridged, round-conic, pointed, medium to large, attractive bright crimson, slightly pitted; flesh light red, firm, juicy, pleasant mild sub-acid, nearly sweet, good; core white, solid; calyx very large, persistent; seeds very many, large. Season, June 12-24; yield 1,866 quarts per acre.

Ninety-Six, S.—(Station plot). In bloom May 3-15-24; poor stand (hills); plants large, vigorous; leaflets medium large, dark; very little disease; runners few; flowers perfect; trusses short, not erect, many flowered; berry not uniform, conic, wedge-shaped to coxcombed, very irregular, large, dark crimson, pitted; flesh red, moderately firm, juicy, mild sub-acid, flat, fair; core solid, light pink; calyx medium, does not separate easily; seeds many, large. Season, June 7-24; yield 2,022 quarts per acre.

Oak Early, S.—(J. G. Harrison & Sons). In bloom April 27-May 8-16; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, necked, round-conic,

medium size, bright crimson, slightly pitted; flesh red, not firm, juicy, mild sub-acid, sweet, fair; core red, solid; calyx small, separates easily; seeds many, large. Season, May 31-June 17; yield 2,147 quarts per acre.

OLIVES PRIDE, S.—(Station plot). In bloom May 2-13-22; fair stand; plants small, not vigorous; leaflets small, light; very little disease; runners few; flowers perfect, small to medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, conic, wedge-shaped, flattened, medium size, bright dark scarlet, slightly pitted; flesh bright red, firm, juicy, sub-acid, nearly sweet, fair; core pink, solid; calyx large, separates moderately easily; seeds many, small. Season, June 12-17; yield 622 quarts per acre.

OOM PAUL, S.—(Station plot). In bloom May 1-23-20; good stand; plants large, vigorous; leaflets medium, dark; little disease; runners not plentiful; flowers perfect, medium to large; trusses large, bending, many flowered; berry not uniform, slightly ridged, cordate, irregularly flattened, coxcombed, very large, bright and dark crimson; slightly pitted; flesh light red, firm, not juicy, mild sub-acid, sweet, good; core red, solid; calyx large, adherent; seeds many, large. Season, June 4-24; yield 1,338 quarts per acre.

PARSONS, S.—(Station plot). In bloom May 4-11-24; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, medium to large; trusses short, bending, many flowered; berry not uniform, broad conic, slightly ridged, wedge-shaped, medium to large, bright scarlet, slightly pitted; flesh light red, firm, juicy, mild sub-acid, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, June 14-24; yield 4,543 quarts per acre.

POCOMOKE, S.—(Station plot). In bloom May 4-18-26; good stand; plants small, not vigorous; leaflets small, dark; very little disease; runners plentiful; flowers perfect; trusses short, not erect, many flowered; berry uniform, slightly ridged, round, blunt, flattened tip, large, bright and dark crimson, slightly pitted; flesh bright red, firm; juicy, mild sub-acid, fair; core pink, not solid; calyx medium, separates easily; seeds many, small. Season, June 4-24; yield 5,663 quarts per acre.

PORTO RICO, S.—(Station plot). In bloom April 26-May 4-16; poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers perfect; trusses moderately large, erect, many flowered; berry uniform, ridged, conic, blunt, flattened, medium to large, bright crimson, pitted; flesh pink, not firm, not juicy, mild sub-acid, fair; core white, solid; calyx medium, adherent; seeds many, large. Season, June 7-24; yield 1,244 quarts per acre.

Pride of Cumberland, S.—(Station plot). In bloom May 3-15-26; good stand; plants large, vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect; trusses moderately large, erect, many flowered; berry uniform, round-conic, blunt, medium to large, bright scarlet, slightly pitted; flesh pink, firm, juicy, sub-acid, good; core pink, solid; calyx medium to large, separates easily; seeds many, large. Season, June 4-24; yield, 4,169 quarts per acre.

Reliance, S.—(W. F. Allen). In bloom April 26-May 6-18; rather poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners very few; flowers perfect; trusses small, erect, many flowered; berry not uniform, round-conic, blunt, flattened tip, medium size, bright scarlet, rather deeply pitted; flesh bright red, not firm, not juicy, sub-acid to acid, fair; core pink, not solid; calyx medium, persistent; seeds many, large. Season, June 4-20; yield 715 quarts per acre.

Repeater, S.—(H. L. Hutt, Guelph, Canada). In bloom May 3-13-20; received very late in the season, and the stand was very poor; plants small, not vigorous; leaflets medium, dark; very little disease; runners few; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, conic, flattened, rough, medium size, bright crimson, pitted; flesh red, not firm, juicy, sub-acid to acid, fair; core pink, solid; calyx medium, adherent; seeds many, small; only a few fruits produced.

Ridgeway, S.—(W. F. Allen). In bloom May 3-13-24; poor stand; plants small, not vigorous; leaflets small, dark; very little disease; runners few; flowers perfect, medium to large; trusses very short, not erect, many flowered; berry uniform, slightly ridged, round-conic, blunt, medium size, bright crimson, slightly pitted; flesh light red, firm, juicy, mild pleasant sub-acid, good; core pink, solid; calyx medium to large, adherent, dry; seeds many, large. Season, June 14-24; yield 1,244 quarts per acre.

Rio, S.—(J. G. Harrison & Sons). In bloom April 24-May 4-18; poor stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners abundant; flowers perfect, large; trusses short, not erect, many flowered; berry uniform, slightly necked and ridged, conic, medium size, dull crimson, slightly pitted; flesh pink, firm, juicy, sub-acid, sweet, good; core white, solid; calyx medium, separates easily; seeds many, small. Season, May 31-June 17; yield 1,213 quarts per acre.

Rough Rider, S.—(J. G. Harrison & Sons). In bloom May 4-11-16; very poor stand; plants small, not vigorous; leaflets small, dark; little disease; runners few; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, conic, round, flattened end, medium to large, scarlet and dark crimson, slightly pitted; flesh

dark red, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx small, adherent; seeds many, small. Season, June 16-20; yield 155 quarts per acre.

Salem, S.—(Station plot). In bloom May 4-11-22; good stand; plants small, not vigorous; leaflets small, light; considerable disease; runners plentiful; flowers perfect, medium; trusses short, erect, many flowered; berry not uniform, ridged, roundish, wedge-shaped, blunt, medium to large, dull crimson, slightly pitted; flesh red, firm, moderately fine, juicy, sub-acid to acid, flat, fair; core red, solid; calyx large, adherent; seeds many, small. Season, June 4-24; yield 4,418 quarts per acre.

Sample, P.—(Station plot). In bloom May 4-18-24; good stand; plants large, vigorous; leaflets medium, dark; considerable disease; runners plentiful; flowers imperfect, medium; trusses short, bending, many flowered; berry not uniform, slightly ridged, round-conic, flattened, large, bright crimson, slightly pitted; flesh rich red, not firm, juicy, mild sub-acid, good; core pink, solid; calyx large, adherent, diseased; seeds many, large. Season, June 10-24; yield 5,663 quarts per acre. Good for home use.

Seaford, P.—(Station plot). In bloom May 4-10-22; fair stand; plants not large, not vigorous; leaflets medium, light green; very little disease; runners plentiful; flowers imperfect, large; trusses large, not erect, many flowered; berry not uniform, slightly necked and ridged, conic, wedge-shaped, blunt, flattened tip, medium to large, bright crimson, pitted; flesh dark red, not firm, juicy, sub-acid, flat, fair; core pink, solid; calyx medium to large, persistent; seeds many, large. Season, June 4-24; yield 3.733 quarts per acre.

Senator Dunlap, S.—(J. G. Harrison & Sons). In bloom April 26-May 4-22; fair stand; plants small, not vigorous; leaflets small, dark; very little disease; runners few; flowers perfect, large; trusses short, not erect, many flowered; berry uniform, necked, slightly ridged, conic, oblong, medium size, dark crimson, pitted; flesh red, not firm, not juicy, sub-acid, flat, fair; core pink, not solid; calyx medium, separates easily; seeds many, large. Season, May 31-June 20; yield 1,431 quarts per acre.

Somerset Maid, S.—(W. F. Allen). In bloom April 24-May 6-18; thin stand; plants small, not vigorous; leaflets small, dark; very little disease; runners not plentiful; flowers perfect, large; trusses short, bending, many flowered; berry not uniform, slightly ridged, conic, irregular, large, bright crimson, very slightly pitted; flesh light red, not firm, juicy, mild sub-acid, fair; core red, not solid; calyx large, separates easily; seeds many, large. Season, June 4-17; yield 1,058 quarts per acre.

Springdale, S.—(Station plot). In bloom April 29-May 6-22; good stand; plants small, not vigorous; leaflets medium, dark; little disease; runners few; flowers perfect, small to medium; trusses large, erect, many flowered; berry uniform, irregular, roundish, flattened, medium to large, light crimson, slightly pitted; flesh light red, not firm, juicy, lively pleasant mild sub-acid, good; core red, solid; calyx large, separates easily; seeds many, small. Season, May 31-June 20; yield 1,609 quarts per acre.

Stakeley, P.—(Station plot). In bloom May 2-13-20; fair stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, conic, wedge-shaped, restricted point, small to large, dull crimson, slightly pitted; flesh rich red, firm, juicy, flat, fair; core pink, solid; calyx large, separates easily; seeds many, small. Season, May 31-June 24; yield 6,411 quarts per acre.

Stella, P.—(Station plot). In bloom May 6-15-20; fair stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers imperfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, roundish, irregularly flattened, medium to large, crimson, slightly pitted; flesh light red, firm, juicy, mild sub-acid, fair; core pink, solid; calyx large, persistent; seeds many, small. Season, June 17-24; yield 1,929 quarts per acre.

Stevens Late Champion, S.—(W. F. Allen). In bloom May 4-15-26; fair stand; plants small, not vigorous; leaflets medium, light green; little disease; runners plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not uniform, hard nosed, ridged, thick irregular wedge-shaped, coxcombed, large, bright scarlet, slightly pitted; flesh light pink, not firm, juicy, pleasant sub-acid, fair; core white, solid; calyx large, persistent; seeds many, large. Season, June 14-24; yield 1,804 quarts per acre.

Success, S.—(H. L. Hutt, Guelph, Canada). In bloom May 4-10-20; poor stand; plants large, vigorous; leaflets large, dark; very little disease; runners plentiful; flowers perfect, large; trusses very short, not erect, many flowered; berry uniform, round-conic, medium to large, dull scarlet, moderately pitted; flesh light red, firm, juicy, sub-acid, fair; core pink, solid; calyx medium, separates easily; seeds many, large. Season, June 7-17; yield 311 quarts per acre.

Superior, S.—(J. G. Harrison & Sons). In bloom April 26-May 4-20; good stand; plants small, not vigorous; leaflets large, dark; very little disease; runners plentiful; flowers perfect, large; trusses short, not erect, many flowered; berry not quite uniform, slightly ridged,

conic, blunt, flattened tip, medium to large, bright and dark scarlet, slightly pitted; flesh light red, firm, juicy, mild sub-acid, sweet, good; core pink, solid; calyx large, adherent; seeds many, large. Season, May 31-June 24; yield 3,298 quarts per acre.

SURPRISE, S.—(Station plot). In bloom April 26-May 9-24; good stand; plants small, not vigorous; leaflets small, light; very little disease; runners plentiful; flowers perfect; trusses medium, large, erect, many flowered; berry not uniform, slightly ridged, round-cordate, oblong, blunt, flattened, medium size, bright scarlet, slightly pitted; flesh pink, firm, juicy, mild sub-acid, good; core light red, soft; calyx medium, separates easily; seeds many, small. Season, May 31-June 24; yield 6,411 quarts per acre.

SUTHERLAND, P.—(Station plot). In bloom May 4-15-20; fair stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers imperfect, small to medium; trusses short, not erect, many flowered; berry uniform, slightly ridged, uneven, conic, blunt, medium to large, bright attractive crimson, slightly pitted; flesh rich red, not firm, juicy, mild sub-acid, nearly sweet, good; core red, not solid; calyx large, adherent; seeds many, large. Season, June 10-24; yield 2,613 quarts per acre. Good for home use.

TENNESSEE, S.—(Station plot). In bloom May 1-11-26; good stand; plants small, not vigorous; leaflets small, light green; very little disease; runners plentiful; flowers perfect; trusses short, not erect, many flowered; berry not uniform, ridged, conic, wedge-shaped, blunt, flattened, fasciated, large, bright scarlet, slightly pitted; flesh bright red, firm, juicy, mild sub-acid, good; core pink, solid; calyx large, persistent; seeds many, large. Season, May 31-June 24; yield 6,658 quarts per acre.

THOMPSON EARLIEST, S.—(Station plot). In bloom April 24-May 4-14; good stand; plants small, not vigorous; leaflets small, dark; considerable disease; runners plentiful; flowers perfect, medium; trusses short, bending, many flowered; berry uniform, slightly necked, roundish cordate, small to medium, dull scarlet, pitted; flesh light pink, not firm, juicy, mild sub-acid, fair; core pink, solid; calyx small, separates readily, considerably diseased; seeds many, large. Season, May 31-June 17; yield 1,369 quarts per acre.

THOMPSON, 203, S.—(Station plot). In bloom April 26-May 6-14; poor stand; plants small, not vigorous; leaflets small, light green; very little disease; runners plentiful; flowers perfect, small to medium; trusses short, not erect, many flowered; berry uniform, roundish, small to medium, rich crimson, slightly pitted; flesh light red, not firm, not juicy, subacid, flat, fair; core red, solid; calyx small, adherent, somewhat diseased; seeds many, large. Season, May 31-June 17; yield 622 quarts per acre.

THOMPSON, 501, S.—(Station plot). In bloom April 26-May 6-16; fairly good stand; plants large, vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry not uniform, slightly ridged, round-conic, irregular, small to large, rich scarlet, pitted; flesh light red, very soft, mild sub-acid, fair; core light red, solid; calyx medium, adherent, diseased; seeds many, large. Season, June 14-24; yield 1,462 quarts per acre.

THOMPSON, 502, S.—(Station plot). In bloom April 24-May 4-20; good stand; plants small, not vigorous; leaflets small, light; considerable disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, cordate, small to medium, scarlet, slightly pitted; flesh rich red, firm, juicy, sub-acid, fair; core red, solid; calyx medium, adherent; seeds many, small. Season, May 31-June 17; yield 2,458 quarts per acre.

TILGHMAN FAVORITE, P.—(Station plot). In bloom May 2-14-22; good stand; plants moderately large, vigorous; leaflets medium, dark; considerable disease; runners not plentiful; flowers imperfect; trusses moderately large, not erect, many flowered; berry not uniform, slightly ridged, hard nosed, long-conic, end very slightly flattened, large, bright dark scarlet, not pitted; flesh pink, firm, moderately juicy, acid to sub-acid, fair; core solid, light pink; calyx very large, persistent; seeds many, large. Season, June 4-24; yield 4,511 quarts per acre.

TOGO SEEDLING, No. 1, S.—(Second generation seedling of Johnson x Tennessee, Station plot). In bloom April 26-May 6-16; poor stand; plants small. not vigorous; leaflets small, dark; very little disease; runners not plentiful; flowers perfect, small to medium; trusses very short, not erect, many flowered; berry irregularly ridged, roundish, wedge-shaped, medium to large, bright crimson, slightly pitted; flesh light rich red, not firm, juicy, mild sub-acid, fair; core red, not solid; calyx medium, separates easily; seeds many, large. Season, June 4-17; yield 342 quarts per acre.

TOGO SEEDLING, No. 2, S.—(Second generation seedling of Johnson x Tennessee, Station plot). In bloom April 26-May 4-20; good stand; plants small, vigorous; leaflets small, dark; very little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry uniform, slightly necked and ridged, round-conic, flattened, large, bright scarlet, pitted; flesh rich red, not firm, juicy, mild sub-acid, good; core pink, solid; calyx small, persistent; seeds many, large. Season, May 31-June 24; yield 1,751 quarts per acre. Good for home use.

TOGO SEEDLING, No. 3, S.—(Second generation seedling of Johnson x Tennessee, Station plot). In bloom April 26-May 4-20; fair stand; plants small, not vigorous; leaflets small, light green; little dis-

ease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, slightly ridged, oval, flattened tip, medium to large, bright attractive scarlet shaded to crimson, slightly pitted; flesh rich red, not firm, juicy, pleasant mild sub-acid, good; core red, solid; calyx small, persistent; seeds many, large. Season, June 14-20; yield 693 quarts per acre.

Togo Seedling, No. 4, S.—(Second generation seedling of Johnson x Tennessee, Station plot). In bloom May 4-13-20; poor stand; plants small, not vigorous; leaflets medium, dark; very little disease; runners not plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, slightly necked and ridged, round, conic, wedge-shaped, medium to large, rich dull crimson, slightly pitted; flesh rich red, firm, juicy, pleasant mild sub-acid, good; core red, solid; calyx large, separates easily; seeds many, large. Season, June 17-24; yield 373 quarts per acre.

Tubbs, S.—(Station plot). In bloom April 24-May 4-16; good stand; plants small, not vigorous; leaflets small, dark; little disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, cordate, flattened, small to medium, bright scarlet, slightly pitted; flesh white, not firm, not juicy, pleasant sub-acid, nearly sweet, good; core pink, solid; calyx small, separates easily; seeds many, small. Season, May 31-June 17; yield 2,302 quarts per acre.

Uncle Jim, S.—(Station plot). In bloom April 27-May-4-14; good stand; plants large, vigorous; leaflets large, dark; little disease; runners plentiful; flowers perfect; trusses large, moderately erect; berry not uniform, much ridged, conic, long pointed, coxcombed, medium to large, scarlet to dull crimson, slightly pitted; flesh light pink, firm, not juicy, sub-acid to sweet, fair; core pink, quite solid; calyx large, separates easily; seeds many, large. Season, June 7-20; yield 3,609 quarts per acre.

Wild Wonder, S.—(W. F. Allen). In bloom April 26-May 8-16; good stand; plants small, not vigorous, leaflets small, dark; considerable disease; runners plentiful; flowers perfect, medium; trusses short, not erect, many flowered; berry uniform, round-conic, small, bright crimson, slightly pitted; flesh red, firm, juicy, mild sub-acid, nearly sweet, fair; core red, solid; calyx small, persistent; seeds few, large. Season, May 31-June 20; yield 1,307 quarts per acre.

Wolverton, S.—(W. F. Allen). In bloom May 1-11-20; good stand; plants small, moderately vigorous; leaflets medium, dark; very little disease; runners plentiful; flowers perfect, medium to large; trusses short, not erect, many flowered; berry not uniform, conic, wedge-shaped, coxcombed, very large, rich bright crimson, slightly

pitted; flesh dark red, not firm, juicy, mild sub-acid, fair; core red, solid; calyx medium to large, separates easily; seeds many, large. Season, June 17-24; yield 3,732 quarts per acre.

Yalu, S.—(Johnson x Star, Station plot). In bloom April 22-May 2-14; good stand; plants small, not vigorous; leaflets large, medium dark; no disease; runners not plentiful; flowers perfect; trusses very short, not erect, many flowered; berry uniform, slightly ridged, conic, medium size, dull crimson, pitted; flesh light red, not firm, moderately juicy, mild sub-acid, fair; core pink, not solid; calyx medium, persistent; seeds many, small. Season, May 31-June 20; yield 1,431 quarts per acre.

Yant, S.—(Station plot). In bloom May 1-13-20; good stand; plants very large, vigorous; leaflets large, very dark; little disease; runners not plentiful; flowers perfect; trusses moderately large, erect, many flowered; berry not uniform, ridged, round-conic, wedge-shaped, coxcombed, very large, bright scarlet to crimson, pitted; flesh light pink, quite firm, juicy, sub-acid, good; core light pink, solid; calyx medium to large; adherent; seeds many, large. Season, June 7-20; yield 3,920 quarts per acre.

THE MARYLAND
AGRICULTURAL EXPERIMENT STATION.

BULLETIN No. 125. FEBRUARY, 1908.

NUT GROWING IN MARYLAND.

By C. P. Close.

The principal objects of this bulletin are, to make a report on the nut survey made in the summer of 1907, to give directions for propagating and planting Persian walnuts and pecans, and especially for top grafting or budding black walnut trees and unfruitful or inferior Persian walnut trees to improved varieties of the Persian walnut, to describe desirable varieties of Persian walnuts and pecans, and to encourage the people of the State to plant nut trees on a commercial basis.

REPORT OF THE NUT SURVEY.

In order to obtain information on the present status of nut growing in all parts of Maryland the writer sent out letters of inquiry to every man or woman who owned a nut tree of any kind so far as he was able to learn. Nearly one hundred people were enough interested to reply more or less minutely to the various questions asked. From nearly every portion of the State the native chestnut, black walnut and hickory, are reported. Occasionally an extra large and sweet native chestnut is mentioned. A few magnificent black walnuts and hickories of thin shell and large sweet kernel have been located. Other natives of less importance abound such as the butternut, hazel nut, chincapin and beach nut. From one place the wild pecan is reported. Scattered efforts have been made to improve a very few of the native nuts of special merit and some effort has been made to introduce cultivated nuts from other supposedly more favorable climes. Being so favorably situated as she is, on the boundary line between the severe cold of the North, and the intense heat of the South, Maryland may well aspire to add the new industry of nut production to her varied resources. A few old pioneer Persian walnut and pecan trees have blazed the way, and extensive orchards of the hardiest of improved varieties of these nuts will surely follow.

Since the state is of such peculiar shape and varies in elevation from sea level in the east, to quite respectable mountains in the west, it is well to divide it into sections of similar soil and climatic conditions and discuss each section briefly.

In the two westermost counties of high elevation and winter temperature dropping occasionally to 20 degrees below zero, all of the native nuts succeed well and thousands of pounds of native chestnuts are shipped from there annually. One man alone gathers and sells a hundred bushels per year. Very little effort has been made to grow improved chestnuts or Persian walnuts and only a few of these trees were reported. In the third county of Western Maryland about 75 Persian walnut trees were reported and most of them are doing well without even ordinary attention in a winter temperature which occasionally reaches ten degrees below zero. Insects and diseases do not trouble the trees to any extent and the cold of winter does little injury. Most of these trees seem to be seedlings not over 30 years old except one which has reached the age of 80 years. In most instances the nuts produced are reported to be equal to and even better, than those purchased in the market. Seedling trees are reported to produce true to type and begin to yield at from six to nine years of age. The yield varies from a few nuts to one peck, or even one bushel per tree. A certain tree now 12 years old has averaged one bushel of nuts annually for three or four years.

One tree cleft grafted on black walnut produced 300 nuts the third year from grafting and more than 1,000 nuts the fourth year. The man who did this grafting thinks that black walnut stock promotes earlier and more abundant yields and that trees on such stocks stand the winter better than those on Persian walnut stocks. Another correspondent believes that trees on black walnut stocks do not stand the winter well. He crown grafts on Persian walnut seedlings only three inches high.

The only nut tree nursery reported in the state is in this section and contains about 1,200 young trees.

Pecans are said to grow slowly and bear at 15 years, there was, however, only one report on pecans.

There was only one report on improved chestnuts and in this the owner says that after ten years he gave up in disgust.

The section north of the District of Columbia and extending east to the Chesapeake Bay, is more favorable for nut culture because of a milder climate than that of Western Maryland. From 75 to 100 Persian walnut trees less than 25 years old are reported in this section. There are also a few old ones. One old land-mark planted about 1850 or earlier and killed by the blizzard of 1900, bore as much as five bushels of nuts per year. Scattering trees 60 feet high produce two bushels per year. The younger trees behave like those mentioned above. Most of the nuts are of good quality and some are thin shelled and of good size. One man reports grafting on black walnut with fair success by the bark grafting method. He cuts Persian walnut cions early in March and stores them in an ice-house until the last of April or first part of May. Then he saws off the stock slanting, splits the bark, makes a four inch slanting cut on one side of the cion and slips it in and waxes the wound securely. One named variety mentioned in this section is Prœparturien.

Only a few pecans are mentioned in this section as are also a few Japan walnuts, chestnuts and filberts. The improved chestnuts have not been profitable generally, and since the various native nuts are so abundant there has not been much incentive to grow cultivated ones.

In the section south of the one just mentioned and between the Potomac River and Chesapeake Bay, there are without doubt many nut trees. but only a few have been located by this survey. The climate is mild, comparatively speaking, and the production of nuts ougnt to be a most tempting vocation in this section.

Doubtless the best portion of the State for the nut industry is the entire Eastern Shore, that is, all of that portion east of the Chesapeake Bay. The climate of this section is modified somewhat by the waters of Chesapeake and Delaware bays and the soil is especially adapted to fruit and nut production. Eighty-five Persian walnut trees were specially reported and others mentioned as being in the various neighborhoods. There are a good many magnificent old specimens from 50 to 80 years old, producing from one to five bushels of nuts annually. One tree 50 years old is said to have produced from three to ten bushels of nuts per year for the last 30 years. Many of these trees yield a product that is equal if not superior to "store" nuts. Nearly all of the younger trees are productive, but a few are not. These are mostly seedlings and usually bear nuts as good or even better, than those from the parent tree. Several grew from nuts grown in California. They began bearing at from five to ten years after planting. One correspondent 84 years of age reports that 50 years ago Persian walnut trees were as common as plum trees in his section of Queen Anne county, but now they are very scarce, having died from utter neglect. There was one orchard of 50 trees. The Grenoble is the only variety mentioned. This began bearing when six years old.

Strangely enough pecans are reported in larger numbers than Persian walnuts in this section, over 200 trees being mentioned. They grow luxuriantly, are not troubled with insects or diseases, and are much used for lawn trees. A few are seedlings grown from nuts obtained in New Orleans. Many of these trees bear thin shelled nuts of good quality, but usually small in size. One tremendous tree 100 feet high and 100 feet in spread of branches with trunk five feet in diameter, is said to have grown from a nut planted 107 years ago. Three other venerable companions of "Father Time" are each 100 years old, and two bear extra good nuts, they are also five feet in diameter. A third "old timer" is 83 years old. The writer measured one tree whose spread of branches is 75 feet and the trunk diameter four feet, but unfortunately the nuts are not edible. Other trees near by bearing good large nuts are 2½ feet in diameter.

One man in Talbot County has 50 seedlings 12 years old, another in Somerset County has 125 fifteen years old which are just beginning to bear choice nuts. Only a few named varieties were mentioned. One correspondent has six Stuart and six Van Deman trees 15 years old. The former began bearing at six years and the latter at 10 years of age. Another correspondent has the Pabst and Alley varieties.

In this section are a few Japan walnuts, filberts, improved hickories and improved black walnuts and an abundance of native nuts. There was one report of three almond trees in full bearing.

Nearly every correspondent from every part of the State except the extreme west, voices the opinion that the Persian walnut particularly can be profitably grown in Maryland if the trees are cared for. Many think the pecan may also be produced with profit.

Nut growing in Maryland may be briefly summarized as follows: The native black walnut, butternut, hickory, chestnut, beech, hazel and chincapin abound almost everywhere. A few of the black walnuts and hickories are of especial merit, and will be utilized as a basis for improving these nuts. Most of the state has produced excellent Persian walnuts and some pecans for more than a hundred years. Only a few named varieties of the improved sorts have thus far been tried. The improved varieties of chestnuts are not generally profitable, but may become so if the immense crop of native chestnuts is cut short as is now threatened by a disease which is causing the death of hundreds of trees from two to three feet in diameter. The Japan walnut is not much grown and is not likely to be. There is an awakening to the possibilities of nut culture, probably caused by the intensely active earnestness with which several of the Southern States are taking hold of this problem, and in a few years Maryland will rank as a nut producing state. She has the requisite soil, climate and incentive, and since satisfactory varieties are to be had, it is now only a question of launching the industry systematically and this movement has already begun.

NUTS AS FOOD.

The planting of nut trees ought to be encouraged and increased until the nuts are produced in large enough quantities to become a staple article of food instead of only a luxury. They can, to a very considerable extent, be used in a mixed diet to take the place of meat. At 20 cents per pound for walnuts and 25 cents per pound for porterhouse steak, an equal investment in each will produce about one-fifth more in weight of food material and in energy in the walnuts than in the steak. (See 1906 Year Book of the U. S. Dept. of Agr.). Pecans rank higher than walnuts in a similar comparison. For use as luxuries only, the addition of thousands of acres of productive nut orchards to our present supply would be profitable.

ACKNOWLEDGMENT.

The writer has had only a limited actual experience with nut trees, but has gained the following information on the propagation, grafting, budding, planting, etc., of nut trees from conversation and correspondence with nut growers in several states, from press reports, and from Experiment Station and Horticultural Society reports. He has drawn liberally on illustrations from the Florida Experiment Sta-

tion bulletins, and the report on the California Walnut Industry, by B. M. Lelong, secretary of the California State Board of Horticulture.

The photographic copying of the illustrations in this bulletin was done by Mr. W. R. Ballard.

PROPAGATING THE *PERSIAN WALNUT.

Since Persian walnut trees of desirable varieties are scarce and expensive it is highly desirable to grow one's own trees if possible. Although this requires more care and attention than the growing of young fruit trees, it can be done successfully on the farm.

The easy though not usually the desirable way is to plant the nuts and grow seedlings for orchard trees. In case one cannot secure grafted or budded trees, but can secure nuts from grafted trees true to the variety name, this practice is allowable because it has been noticed on the Pacfic Coast that in such an event about one-third of the resulting seedlings produce nuts like the parent, one-third produce nuts superior to the parent, and the other third produce nuts inferior to the parent. The inferior seedlings could be grafted or budded to the parent variety, but time is lost in doing this and it would be better practice to set grafted or budded trees.

Figure 1.—(After Hume—Florida Agrl. Expt. Sta. Bul. No. 85). Whip grafting pecans at the crown in nursery row.

Planting the nuts.—The seedlings of either Persian walnut or black walnut are used as stocks upon which to graft the Persian walnut. The nuts may either be stratified in damp sand or planted in the nursery rows in the fall, or be kept dry for spring planting. When the latter is done it is well to soak the nuts in warm water twenty-four hours just previous to planting. Nuts are stratified in a box or cold frame by putting in alternately three or four inches of earth and

*This is usually called the English walnut and often the Madeira nut.

nuts. Keep moist in a cold place. Plant the nuts in rows four feet apart and eight inches apart in the row. Cultivate and care for the seedlings so they will grow as large as possible during the first season. Most of this growth will be in the roots.

Crown-grafting the seedlings.—When the seedlings are one year old they may be crown grafted as they stand in the ground. Remove the earth and take off the top at the point where it swells in joining the root as shown in Figure 1. Either the cleft or whip method may be employed. Make cions five or six inches long of well matured wood with strong plump buds of the previous season's growth. Have cion and root about the same size if possible. For cleft grafting trim one end of the cion to a wedge shape with one side of the wedge a little thicker than the other and with the cut or scarf of *one side only* through the pith, as shown in Figures 2 and 3. A bud should be lo-

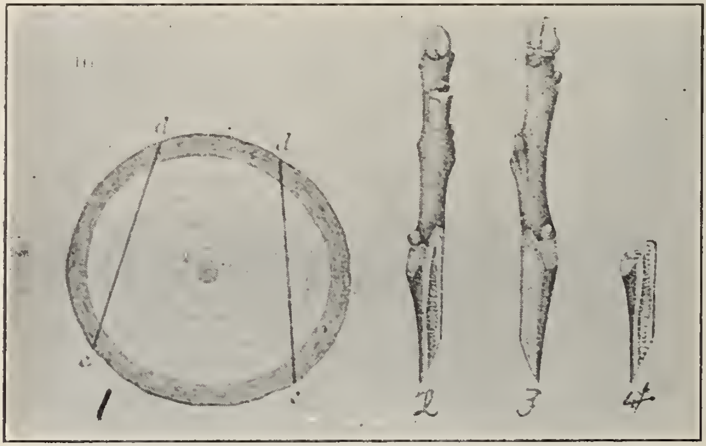

Figure 2.—(Cut taken from "Nut Culture in the United States"). Cleft Sap Grafting.

1. The lines d e show where the clefts should be made.
2. Cion ready for cleft grafting. Note scarf cut through pith.
3. Opposite side of cion shown in 2, note the scarf does not touch the pith, also note position of bud at upper end and between scarfs.
4. Shows size of pith in cion.

cated at the upper end of the scarf cuts on the thicker outer side of the cion. Make a cleft or split in the root and place the wedge end of the cion, thick side out, tightly into the cleft, being most careful to have the light colored inner bark of the cion and root touch because this is the point where the cion and root grow together. It is well to cross the cion and root very slightly so as to be sure that the light colored or cambium layers of bark touch at some point. Wrap tightly with large soft twine and cover all cut surfaces carefully with grafting wax as shown in Figure 4. Do not cover the string with wax clear around the graft, leave part of it uncovered as shown in Figure 3 so it may decay before it chokes the growing union. Mound the earth up firmly to the top bud of the cion.

If the whip or tongue graft method is used the cion and root are both trimmed alike as shown in Figure 5. A long smooth cut is made across each and a second cut between the pith and bark is made parallel with the long side to form the tongue. These prepared ends are fitted tightly together so that the cambium layers of bark touch, the union is wrapped with twine and waxed, and the earth mounded around the cion exactly as in cleft grafting.

Figure 3.—(After Lelong—California Walnut Industry).
Cleft Grafting the Walnut.
1. The prepared cion.
2. Cion inserted in cleft.
3. Cion tied and waxed—three weeks growth.

In California the seedlings are sometimes dug for indoor cleft or whip grafting like that practiced with apples. (See Figure 4). This

method is not likely to be successful unless the grafts are started in the greenhouse.

TOP WORKING WALNUTS.

There are many black walnut and seedling Persian walnut trees in the State which ought to be top grafted to the improved French

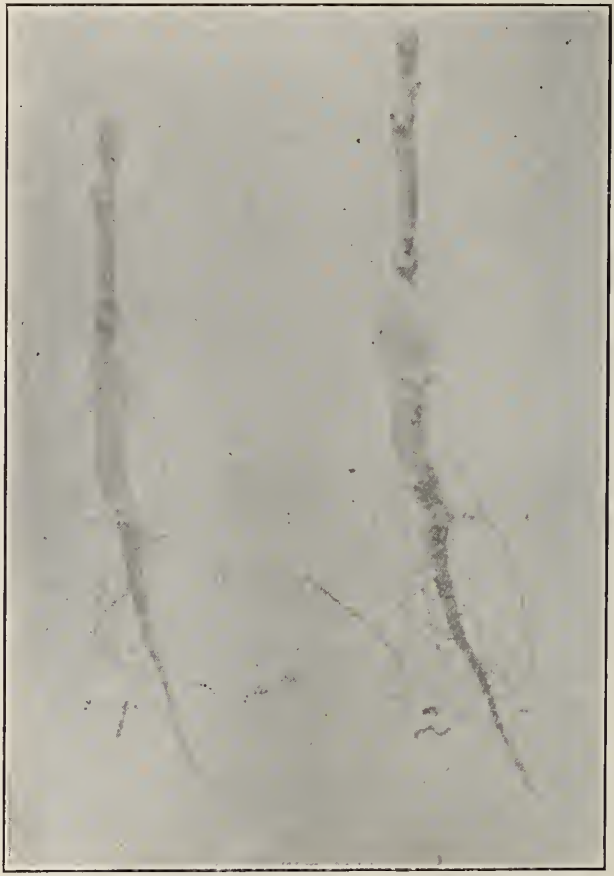

Figure 4.—(After Lelong—California Walnut Industry).
Root Grafting the Walnut.
1. Root with cion inserted, ready for waxing.
2. The same waxed and ready for planting.

varieties or to some extra good seedlings. The time to do this is in the spring just as growth is starting, but the cions should be taken early in spring and be kept dormant in moist sand in an ice-house or other cold place.

Cleft sap method.—It is best to use limbs from one to two inches in diameter for grafting, but those three or four inches in diameter may be used if necessary. Figures 2 and 3 show how this may be done. Saw off the limb and trim the end smooth with a sharp knife. Split the stub with the grafting chisel *through the sap wood* as shown by the lines d e in Figure 2. *Do not make the cleft through the pith.* Trim the cions to a wedge shape, as shown in Figures 2 and 3, and as described under, "Crown grafting the seedlings." Push the cion firmly into the cleft, thick side out, slightly crossing it with the stock so the cambium layers of bark will touch. In limbs over an inch in diameter put from two to four cions, as they help to heal over the wound and

Figure 5.—(After Hume—Florida Agrl. Expt. Sta. Bul. No. 57).
Whip Grafting.
1. The stock Prepared.
2. The cion prepared.
3. The two united.

the extra ones may be cut off after one year's growth. As soon as the cions are in place bind stout twine or waxed cloth around the stub to prevent the clefts from opening up and the cions from loosening, and cover every cut or split portion of bark or wood with grafting wax to prevent any drying out of the stock or cion. This is important and the wax must be examined occasionally and kept in place during the entire season. If limbs are too large or too high up for grafting, the tree may be stub pruned as shown in Figure 8. This pruning forces out new shoots which may be either budded or grafted.

Prong grafting or prong budding.—Figure 6 illustrates this method very plainly. Saw off and smooth the end of the limb, and two inches below make the T-shaped cut as shown at 1. With a sharp thin bladed knife take off the prong beginning to cut about an inch below the prong and extending the same distance above. This will leave

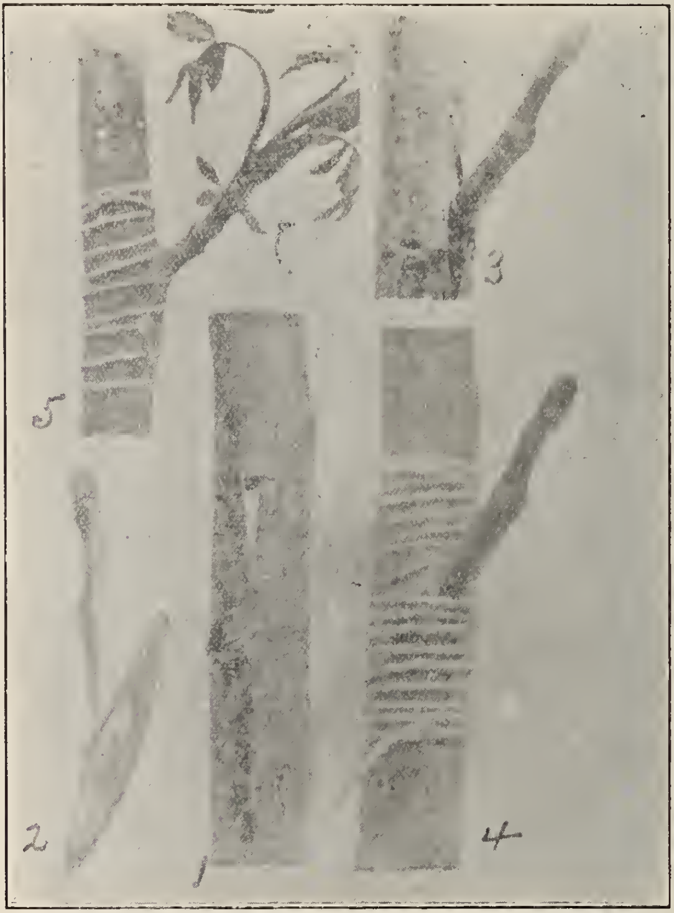

Figure 6.—(After Lelong—California Walnut Industry).
Prong Budding the Walnut.
1. The stock cut off and T shaped incision made.
2. The prong bud prepared for placing in incision in 1.
3. The prong bud inserted.
4. The twine in position to hold prong bud in place.
5. The completed job, waxed, retied and growing.

considerable bark and a little wood on the prong. Remove the wood and the prong will appear as at 2. Slip the prong between the lips of the T-shaped cut on 1 and it will take the position shown at 3. Now

wrap tightly with large soft twine as at 4 and cover all cut surfaces, including end of stub, carefully with grafting wax. Watch for the enlarging of the stock and if the string cuts into the bark loosen it and tie again. The prong starting into growth is shown at 5.' The new growth is very tender and should be protected in some way from being broken by the wind or by birds lighting on it. It may be tied to the stub.

This operation is done in spring when growth is starting and the bark will peel. The prongs are taken from twigs grown the previous season and are usually from one to two inches long. These twigs should be secured early and kept dormant as mentioned for cions.

Annular budding.—This method of budding is the best one to use on young trees and older limbs with smooth bark. It is done in summer or fall when the bark peels readily. If done in early summer the buds are taken from cions of the previous season's growth which have been kept in moist sand in an ice-house or other cold place. The bud stick and stock ought to be about the same size so that the ring of bark will fit well. Choose a plump bud and remove it with a ring of bark an inch or more wide as shown in Figure 7. Take a similar

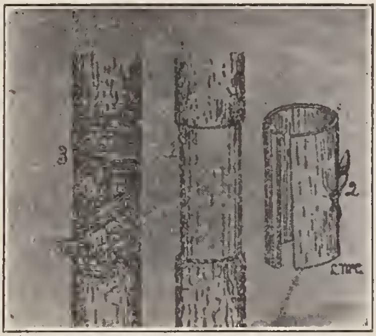

Figure 7.—(After Hume—Florida Agrl. Expt. Sta. Bul. No. 57).
Annular Budding.
1. The stock prepared for bud.
2. The bud with ring of bark.
3. The bud in place and tied.

ring of bark off the stock and slip the bud ring in its place. Wrap well with waxed cloth to protect all cut places from drying out. The buds put in during August and September remain dormant until spring. When they start growing the limbs should be cut off a few inches above the buds and a month or so later the stubs should be cut off just above the new shoot. In summer budding the buds soon begin to grow and the limbs must be cut back from time to time so as not to check the new growth.

A simple implement for cutting rings of bark of uniform width is made by tying together two budding knives with a small block of wood between them. A double cut is thus made around the bud stick, then

one downward slit is made on the side opposite the bud so the ring may be peeled off easily.

PROPAGATING THE PECAN.

The pecan is propagated in about the same way mentioned for the Persian walnut. What has just been given on cleft and whip grafting of seedlings, on top working by whip grafting on small limbs and cleft

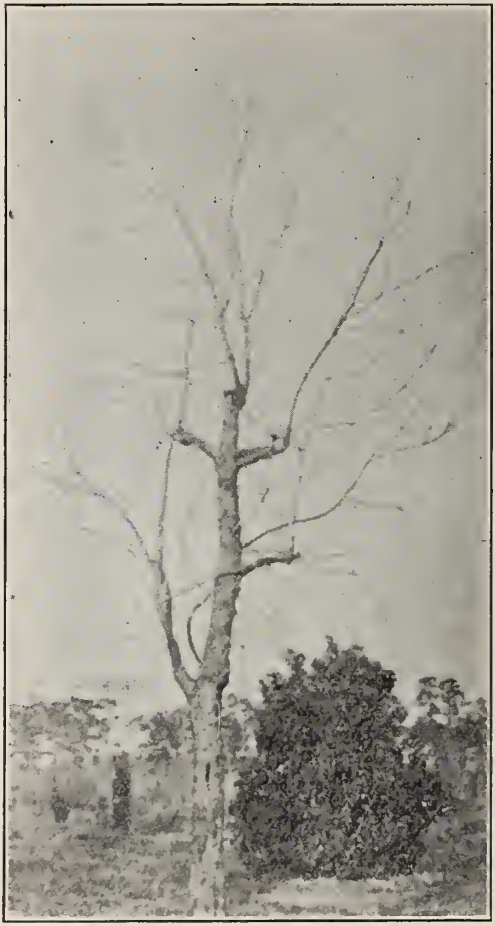

Figure 8.—(After Hume—The Pecan and Its Culture).
An old Pecan Tree Topworked in the Branches.

sap grafting on larger limbs, and on annular budding of the Persian walnut applies also to the pecan. In stratifying the pecans for planting, more care is necessary than with walnuts. Boxes about three feet long, one and one-half feet wide and six or eight inches high are

preferred. Spread two inches of moist sand in the box, then a single layer of nuts, add sand and nuts alternately until the box is full. Cover with straw or hay to prevent drying out. The nuts usually sprout by spring. When the ground is well prepared the nuts should be planted about five inches deep in rows three or four feet apart and about eight inches apart in the row. If the little seedlings make a good growth the first season they may be crown grafted the next spring as shown in Figures 1 and 4. The smallest seedlings may be budded the following August or be crown grafted the second spring from planting the nuts.

Top working old pecan trees.—If the tree to be top grafted or top budded has too high a top, and it is desired to lower the top before doing the grafting or budding, this may be done easily by cutting off part of the top and forcing out new shoots nearer the ground, as shown in Figure 8. These new shoots may be either grafted or budded.

TOOLS AND ACCESSORIES FOR GRAFTING.

To attain success in the grafting and budding of nut trees the utmost care and accuracy of manipulation are necessary. Everything used should be especially adapted for its particular use.

Budding knife, for cutting buds and trimming cions. This should have a thin, sharp, keen-cutting blade, because ragged cutting means failure. See Figure 9.

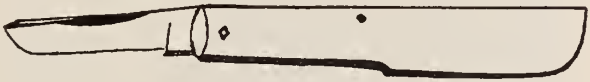

Figure 9.—Budding Knife.

Double budding knife, for taking off rings of bark in annular budding. This may be made by tying or riveting two budding knives together using a small block of wood to separate the blades from one inch to one and one-half inches.

Grafting chisel, for making clefts in cleft sap grafting. This may be purchased from seedsmen or be made by a blacksmith. The blade should be sharp and not too thick. See Figure 10.

Figure 10.—Grafting Chisel.

Wooden mallet or some substitute, for driving grafting chisel into the wood.

Twine or raffia, for binding material in grafting and budding. A large soft twine is better than a smaller hard twine. Raffia may be purchased from seedsmen, it should be moistened before being used.

Grafting wax, for covering all cut surfaces in grafting or budding. Use four pounds rosin, two pounds beeswax and one pound tallow, or six pounds rosin, two pounds beeswax and one pint linseed oil. Melt the rosin and let it simmer a few minutes. Trim off hard dark colored surface of beeswax, shave up the balance and add to melted rosin and cook a few minutes. Add tallow, cook and stir a few minutes and pour all into cold water. Grease the hands and pull and work the wax until it becomes a light yellow color. Mould in rolls or balls, wrap in oiled or greased paper for future use. Make the rosin-beeswax- linseed oil wax in the same way. If the weather is cold when grafting is done the wax must be softened in warm water.

Figure 11.—(After Hume—Florida Agrl. Expt. Sta. Bul. No. 54). 1. Two year old pecan tree, tap root was cut when one year old. 2. Two year old pecan tree, tap root was never cut.

Waxed cloth and waxed twine, for binding around buds or grafts to hold them in place and exclude air. Dip old calico or cotton cloth into melted grafting wax and spread on a board or box to cool. Tear into strips when ready for use. For waxed twine use balls of No. 18 knitting cotton, dip into melted wax until saturated and hang up to cool.

Surgeons' adhesive plaster, used like waxed cloth or waxed twine. Dr. Robert T. Morris, of New York City uses this with good suc-

cess, especially in budding nut trees. It excludes the air and rain admirably. It can be purchased in drug stores.

Liquid grafting wax. The writer has used liquid grafting wax successfully in grafting fruit trees and doubtless it will be satisfactory on nut trees. It has the advantage of being pleasant and clean to handle as it is kept in bottles and is spread with a brush. Use one pound of white rosin and one ounce beef tallow, melt these together and *remove from the fire;* then add slowly eight ounces of alcohol stirring constantly until smooth. Put in bottles and cork tightly.

Figure 12.—(After Hume—Florida Expt. Sta. Bul. No. 85). Root system of a well grown pecan tree. The tap root was cut in the nursery when one year old.

PLANTING THE TREES.

The old idea that these nut trees will die if the tap root is cut has been exploded. It would be desirable to cut the tap roots of all yearling trees in the nursery so as to force out lateral roots and thus make a better root system. Figure 11 shows two tap roots two years old, the left one of which was trimmed off when one year old. Figure 12 shows a well branched root system resulting from pruning the tap

root. Trees two or three years old so treated will transplant much more successfully than trees of the same age which have never had the tap root cut.

Preparing trees to plant. In preparing trees for planting leave from 15 to 24 inches of tap root on small trees, and from 20 to 30 inches on larger trees. Cut off all bruised or broken parts of roots, leaving smooth clean cuts. New tap roots usually develop if the tree has need of them.

The top will probably not need pruning except to remove broken or bruised limbs.

Caution. Do not allow the roots to become dried out the least bit. It is best to dip the roots in thin mud as soon as unpacked and heel in at once. When planting take out a few trees at a time and wrap the roots in wet burlap bags until planted.

Setting the tree. The hole should be large, three feet across, and deep enough to set the tree an inch or two deeper than it was in the nursery. Place the tree in position and fill in with rich surface soil, packing it firmly around all of the roots. Mulch the surface around the tree with manure to retain moisture and enrich the soil.

Orchard and lawn planting. One special object of this bulletin is to encourage orchard planting of nut trees, rather than lawn planting so as to start the industry on a large scale. However, the planting of these trees on lawns, along highways, lanes, fence rows, etc., to replace maple and other shade trees, is earnestly recommended. No more beautiful ornamental trees than these could be wished for and they are at the same time profitable.

They should be planted at least 40 feet apart along highways, lanes, etc., and 50 feet apart in orchards. At this latter distance it requires 17 trees per acre. Other orchard trees like apples, pears, or peaches may be used as fillers until the nut trees require all of the space. The fillers may be set $16\frac{2}{3}$ feet apart in the nut tree rows and two extra rows of fillers $16\frac{2}{3}$ feet apart may be set between each two rows of nut trees. Thus the entire ground is occupied and may be handled as mentioned under, "Cultivation and Crops."

SOIL.

The most desirable soil seems to be a good sandy loam with clay subsoil. Almost any good well drained soil not underlaid with hardpan and not in too low a situation, will doubtless be entirely satisfactory.

CULTIVATION AND CROPS.

For the best success the trees ought to be given as good care and cultivation as any peach or apple orchard receives. Such crops as tomatoes, round or sweet potatoes, sweet corn, melons, cowpeas for fodder or seed, may be grown in the orchard for perhaps ten years or until the trees are bearing fair crops. Liberal amounts of fertilizer

should be used on the crops so the nut trees will not be injured or stunted. Early in August the cover crop seed should be sown. Crimson clover seed, 20 pounds per acre, ought to produce a satisfactory cover crop. This should be plowed down in spring and the ground cropped again.

Figure 13.—(After Lelong—California Walnut Industry). Staminate catkins or male flowers below, female flowers at tip of twig. Staminate catkins are on twig one year old, female blossoms are on new growth.

WINTER PROTECTION.

It is a common experience that nut and some other trees for the first few years are tender enough to be winter injured, but after that they become hardy. For this reason it is highly desirable to wrap them in burlap, straw, corn stalks, or other material to protect from

severe cold and also from the warm rays of the winter sun early in the afternoon on mild days. The sun about 2 o'clock P. M. will often warm up the south-west side of the tree enough to start a movement of sap. In two or three hours the temperature may drop to the freezing point and the thawed bark is again frozen. This freezing and thawing continues until the tender cell walls are ruptured and the bark discolors and dies. This result is commonly called sun scald and it may in time kill the tree. It is also well to mound the earth a foot high around the tree trunk.

Figure 14.—(After Hume—The Pecan and Its Culture).

Catkins of male Pecan blossoms on one year old wood and female blossoms on new wood shown by arrow. Female blossoms in lower corner.

In climates where injury by severe cold is not feared it is well to at least shade the trunk on the south-west side by means of a narrow board or veneer protector.

BLOSSOMS.

The blossoms are peculiar when compared with fruit tree blossoms. The male and female blossoms are entirely distinct in appearance and position. The former are long showy catkins, coming nearly always from one year old twigs and appearing at the same time or a week or two before the inconspicuous female blossoms at the terminals of the new growth. Figure 13 shows the large male catkins of the Persian walnut on one year old wood and the female flower cluster on the new growth. Figure 14 shows similarly the male and female pecan blossoms although the latter are indistinct, but are shown alone in the lower corner of the picture.

VARIETIES OF PERSIAN WALNUTS.

From the best information the writer could obtain it seems that the varieties mentioned below will succeed in Maryland. It is necessary for trees here to be slow in starting into growth in spring and late in blooming so as to avoid injury by late frosts. The following varieties are doubtless all satisfactory in these respects. The first five are thin shelled French varieties and the descriptions of them are taken from "California Walnut Industry." They are all productive bearers.

Chaberte. Fair sized, roundish-oval; kernel extra fine quality.

Franquette. Quite large and attractive, elongate-oval; kernel full fleshed and sweet, and of a rich, nutty flavor. Blooms late in spring and is as hardy as Parisienne and Mayette Blanche.

Mayette Blanche. One of the finest dessert and market nuts grown. Especially valuable because of being so hardy and such a late bloomer. Quite large and uniform, roundish; kernel full-fleshed, sweet and nutty. It is often called Grenoble.

Parisienne. Larger and broader at apex than Mayette Blanche and equal to it in all respects.

Proeparturiens. Medium size, very sweet kernel, extra early bearer.

San Jose. This is a seedling of Mayette Blanche originated several years ago by Mr. R. Wiltz, 16 Lucretia Avenue, San Jose, California. It is considerably larger than any of the above varieties, a late bloomer, an early and prolific bearer, as hardy as its parent, and is thin shelled and of excellent quality. It is extremely promising for Maryland.

Rush. This originated with Mr. J. G. Rush, West Willow, Pa. It is hardy and one of the most promising varieties for Maryland. It is larger and rounder than Mayette Blanche and is of good quality.

Norman Pomeroy. This was originated by the late Norman Pomeroy of Lockport, New York. It is claimed to be a very late bloomer, an early and prolific bearer and entirely hardy where it originated. It is not as large as the Rush. The quality is good.

Drew. The Drew is a medium sized nut originated in Milford, Delaware. The writer obtained specimens of the nuts from Mr. David Greenawalt, Chambersburg, Pa.

Peerless Paper Shell. This was originated by Mrs. Rebecca E. Semple, 217 East Broad Street, Burlington, N. J., from a nut planted by her fifteen years ago. The nuts are extra large, with thin but rough shell; kernel large and of good quality. This is promising for Maryland. The young trees need protection in winter for three or four years.

A number of good unnamed seedlings have been located in various parts of the East, and as far as possible these will be propagated at the Experiment Station and tested in various parts of the state. Reports on these will be published in due time.

VARIETIES OF PECANS.

Varieties of pecans for Maryland cannot be recommended with as much certainty as can Persian walnuts because the pecan has not yet received much attention in localities far north of its native home. From the few efforts at pecan growing already made in the state there is reason to believe that the most hardy varieties will succeed here. The following varieties were suggested by Prof. H. Harold Hume, who has had considerable experience with pecans in the Southern States. The descriptions are abbreviated from the full descriptions of varieties by Prof. Hume in "The Pecan and Its Culture."

Curtis. Medium size, 1⅝ x ⅞ inches, ovate-conical, with pointed apex; shell thin, kernel plump; flavor sweet, rich, nutty; quality excellent.

Horlbeck. This is one of the newer varieties and no description is available.

Mantura. Large size 2 x ⅞ inches, oblong-oval, blunt pointed at base, sharp pointed at apex; shell very thin, cracking quality very good; kernel plump; flavor sweet, nutty; quality very good.

Moneymaker. Size medium, $1\frac{5}{16}$ x 1 inches, ovate-oblong; base rounded, apex abruptly rounded, slightly wedged; shell medium thick, cracking quality very good; kernel plump; flavor sweet, good; quality very good.

Pabst. Size large, 1⅝ x ⅞ inches; oblong-cylindrical, base rounded, apex blunt, four angled, grooved; shell medium thick; cracking quality fair; kernel plump; flavor good; quality very good.

Stuart. Large to very large, 1⅞ x 1 inches; ovate-cylindrical; base rounded, tipped; apex blunt, abrupt, somewhat four angled; shell medium thick; cracking quality very good; kernel plump; flavor rich, sweet; quality very good.

Van Deman. Large to very large, 2⅛ x 1⅞ inches, oblong-cylindrical, base sloping, blunt-pointed; apex tapering, sharp pointed; shell medium thick; cracking quality fine; kernel fine grained and compact, sometimes slack at end; flavor sweet and delicate; quality very good.

CONCLUSION.

There is scarcely any good reason why people who own favorably located, well drained land without hardpan subsoil in Maryland, should not plant nut trees, especially the Persian walnut and pecan. The old argument, "I am too old to plant trees," is out of date, and any loyal citizen ought to be ashamed to hide behind such a flimsy excuse. There are comparatively few people in the State who are really too old to receive some benefit from, or to take pride in, trees of their own planting. Many of the varieties mentioned above will bear at from six to eight years from planting and at from two to four years from top grafting or top budding. These few years pass rapidly and even though the one who plants does not reap the harvest, he or she plants for future generations and erects in these trees monuments to keep his or her memory green for many scores of years.

The young and middle aged should not only plant nut trees themselves, but should encourage the children to do likewise. Every farm boy ought to have a small nut nursery and be taught to plant and care for nut trees. Nothing more creditable could be done in the schools than to interest the boys and girls in the possibilities of nut production and to celebrate Arbor Day with the planting of nut trees. The Maryland Experiment Station will attempt to furnish free of cost one or two nut trees to the first fifty schools of the State who apply for trees to plant on Arbor Day, 1908, providing the requests are sent in before definite plans have been made to use all of the trees on hand for experimental work. If any interest is shown by the schools in this subject the Experiment Station will endeavor to furnish trees free of cost to them for Arbor Day planting in 1909.

In the spring of 1907 the Experiment Station sent 74 Persian wanut trees to 16 localities in the State. This year the Station purchased nearly 1,200 trees of Persian walnuts and pecans for establishing eight or ten test orchards in different portions of the state, and for sending to individuals for testing in from 75 to 100 different localities. In this way it is hoped to determine the usefulness and range of the different varieties of Persian walnuts and pecans and to create a healthy interest and rapid growth in the nut industry. If the writer's efforts in this work are rewarded by making one hundred nut trees grow in the near future where one nut tree is growing today, he will feel well repaid for his work.

THE MARYLAND

AGRICULTURAL EXPERIMENT STATION.

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MANURING AND FERTILIZING TRUCK CROPS.

By C. P. Close and Thomas H. White.

The radical differences in the practices and opinions as to the proper use of manure and fertilizers between the growers of the staple farm crops and the growers of the truck crops, and the fact that many of these opinions are not supported by the theories frequently worked out and presented by scientists, called forth the few experiments reported upon in this bulletin.

These tests cover only a portion of the points upon which there is much debate and it is to be regretted that the facilities at hand would not permit taking up the questions on a much broader and more extensive scale; yet the results would seem to be of sufficient interest and value to warrant a report at this time.

It had been noticed that where corn land had been treated with animal manure there was invariably an increase in the crop while the same land treated with chemicals would very often "fire" the corn, or in other words the stalks would become prematurely ripe with a resulting decrease in the yield of grain. As it is the usual practice to spread stable manure on the surface and turn under at the time of plowing, it was thought perhaps something might be learned about this matter if chemical fertilizers were used in the same way.

In considering this plan of procedure it was of course understood that this manner of applying commercial fertilizers while being radical might also be wasteful. Still not necessarily so, when it is considered that the more valuable parts of animal manures become easily soluble yet they seem to be retained by the soil for a long period. For instance, manure is frequently plowed down in the fall several months before the crop is planted.

STUDIES MADE WITH REFERENCE TO TRUCK CROPS OR A TRUCK FARM ROTATION.

The tests reported upon in this bulletin were conducted on four series of plots, known as A, B, C, and D.

Series A was started in 1902.
Series B was started in 1903.
Series C was started in 1904.

Series D was started in 1899.

The following is a list of the points under discussion and upon which it was desired to get information concerning:

1--Comparison of stable manure and commercial fertilizer.

2—Comparison of plowing commercial fertilizer under, and using it as a top dressing harrowed into the soil just before planting the crop.

3—Comparison of heavy and light applications of commercial fertilizers.

4—Comparison of heavy and light applications of stable manure.

5—Comparison of fresh and rotted stable manure.

6—Comparison of rotted manure turned and unturned while in the compost heap.

7—Comparison of commercial fertilizers derived entirely from mineral sources with those derived entirely from animal and vegetable sources.

8—Comparison of the use of stable manure and commercial fertilizers for sweet potatoes.

PLAN OF EXPERIMENT.

The plan as outlined was to use manures and commercial fertilizers in connection with green crops turned under, and to plant truck crops rather than general farm crops. Also on series B and C the fertilizers were mixed so as to compare with barn-yard manure especially in the nitrogen content. The aim was to supply the same amount of actual plant food in the form of chemical fertilizer as was found in the stable manure. Wishing to make the experiments comprehensive and useful to the reader who desires to follow the several seasons' work in detail, the series are at first discussed at length. Later the comparisons are made under their several headings in separate tables.

SERIES A, STARTED 1902.

The plots 1, 2, 3 and 4 were 21⅞ ft. x 100 ft. containing about $\frac{1}{20}$ of an acre.

Plot 1—Received the rate of 15 tons of good stable manure per acre *plowed down* in the spring.

Plot 2—Received commercial fertilizer 750 lbs. per acre at planting time.

Plot 3—Received same as plot 2, but the fertilizer was sown on and *turned under* with the sod the same as the stable manure in the spring.

Plot 4—Was the check or "nothing" plot receiving no fertilizer.

The soil was a stiff loam underlaid with clay. The land had been in timothy sod for two years. All of the plots were plowed on April 20. The first crop was late cabbage. The ground was kept mellow and clean by harrowing. On June 15 the fertilizer was applied to plot 2 and the land was prepared for cabbage.

Table I shows for each plot the kind, amount and value of fertilizing material used in 1902, the yield and value of crop and the gain in dollars by the use of the fertilizers and manure.

Table I. Shows for 1902 the Kind, Amount, Value and Application of Fertilizing Material, the Yield and Value of Cabbage Crop, and the Gain by Use of Fertilizers and Manures.

Plot number and treatment.	Kind of fertilizer.	Per cent. of plant food applied, fertilizer.	Weight of crop, pounds.	Value of crop at ½¢ per lb.	Cost of fertilizer.	Gain from fertilizer.
Plot 1. Manure plowed down April 20.	Stable manure 15 tons.	Nitrogen .4 Phos. acid .2 Potash .5	35389	$176.94	$30.00	$107.21
Plot 2. Com. fertilizer sowed on surface at planting time, June 15.	Dissolved S.C. rock, 348 lbs. Dried blood, 186 lbs. Muriate of potash, 112 lbs Nitrate of soda, 113 lbs.	Nitrogen .5 Phos. acid .7 Potash .7	33772	$168.86	$11.08	$118.05
Plot 3. Com. fertilizer plowed down April 20.	Same as plot 2.	Same as plot 2.	37976	$189.88	$11.08	$139.07
Plot 4. Check, Received no fertilizer.			7946	$ 39.73		

After the cabbage was harvested the plots were seeded to rye. On April 24, 1903 a square yard of the rye was cut and weighed green. After drying it was weighed again. The green and dry weights follow:

	Lbs. per acre green.	Lbs. per acre dry.
Plot 1	9680	1512
Plot 2	6352	1058
Plot 3	8772	1361
Plot 4	2722	454

Plot 1 received manure and plot 3 received fertilizer as in 1902, and on April 24, 1903, the green rye was turned under. The ground was kept in good condition and on June 26 the fertilizer was applied to plot 2.

Stowell's Evergreen sweet corn was planted on June 26 and made a poor stand and a poor growth on account of the wet season.

Plot 1 had about 5% of a stand with poor growth and medium sized ears.

Plot 2 had about 50% of a stand with growth and ears like plot 1.

Plot 3 had about 80% of a stand, otherwise it was like plot 1.

Plot 4 had about 80% of a stand with poor growth and no marketable ears.

It is interesting to note that the corn came up better on plot 3 which had the fertilizer plowed under in the spring and on plot 4, the

Rye from Plots 1, 2, 3 and 4, Series A, 1903.

check plot, than on either of the others. The stand being so irregular it was impossible to secure accurate data, therefore no other records were kept of this crop.

Crimson clover was sown at the last working of the corn.

By May 1, 1904, the crimson clover was coming into bloom. Plot 1 had a good stand and the best clover of any of the plots. Plot 2 was not quite as good as plot 1. The stand on plot 3 was not very good, but the plants were vigorous and strong. Plot 4 was very poor in stand and growth.

On May 16, 1904, plot 3 received its usual amount of commercial fertilizer. Plot 1 which had received stable manure the two previous seasons had nothing put on this year because it was thought that there being a much larger amount of plant food in the manure than in the fertilizer, it would be a fairer comparison to leave off the manure for one season. The plots were all plowed on May 16 turning under the crimson clover.

On June 17, plot 2 received its dressing of commercial fertilizer as in the years previous and the ground was prepared for late cabbage.

The yields for 1904 and the increase in value of the fertilized plots over the check plot are as follows:

Plot.	lbs.	Value at ½¢ lb.	Value of fertilizer.	Gain over check.
1	9280	$46.40	.....	$35.50
2	7780	38.90	$11.08	16.92
3	8540	42.70	11.08	20.82
4	2180	10.90	.....	.....

Check Plot Series A, Showing the Poor Grade of the Cabbage.

The cabbage was harvested so late that the cover crop seed could not be put in.

On April 3, 1905, plot 1 received manure and plot 3 fertilizer as usual.

The plots were all plowed on April 18 and the fertilizer was applied to plot 2. Maine grown Early Rose seed potatoes cut to one eye were planted at once.

The weather was very dry, and the stand of vines was very poor.

The potatoes were dug September 7 and the yield was as follows calculated per acre:

Plot.	1st grade lbs.	2nd grade lbs.	Value.	Value of fertilizer.	Gain over check plot.
1	3820	1080	$40.90	$30.00	$7.60
2	2200	920	24.31	11·08	9.93
3	2240	700	24.15	11.08	9.77
4	260	280	3.30	.....	....

The first grade was valued at 60 cents per bushel and the second grade at 15 cents per bushel.

On September 16, 1905, Alsike clover was sown on all of the plots. This was mostly winter killed and on April 7, 1906, the ground was disc harrowed and again seeded with a mixture of Alsike and red clover. A good stand was secured and late in the summer this was cut and left on the ground.

On June 28, 1907, the clover was cut and cured for hay. The yields and value per acre of the plots follow, calculating hay at $15.00 per ton:

Plot.	lbs.	Value.	Gain over check plot.
1	6800	$51·00	$42.00
2	4000	30.00	21.00
3	3800	28.50	19.50
4	1200	9.00	.....

After removing the hay, plots 1 and 3 received the manure and fertilizer as in previous seasons and the plots were all plowed.

On July 8, plot 3 received its portion of fertilizer which was harrowed in. The plots were then planted to cabbage and the crop was harvested on October 10. The yields, value of crop and fertilizer and gain per acre over check plots follow:

Plot.	lbs.	Value of crop.	Value of fertilizer.	Gain over check plot.
1	19360	$96.80	$30.00	$35.34
2	24200	121.00	11.08	78.46
3	28092	140.46	11·08	97.92
4	6292	31.46	.....	.....

Table II is a summary of the results of the five years' work in series A, and shows the total amount and value of the manure and fertilizer applied to the plots, the total value of the crops on the different plots and the gain of the fertilizer plots over the check plot. All figures are given at the acre rates. The commercial fertilizer plots gave greater gains than the manure, especially the one where the fertilizer was plowed down in the spring.

Table II. Shows Total Amounts and Value of Manure and Fertilizer per Acre Applied to Series A in the Five Years and Total Value of Crops and Gain per Acre for Fertilizer Over the Check Plot.

Plot Number and treatment.	Total amount of fertilizer applied per acre.	Value of Fertilizer per acre.	Value of all crops per acre.	Total gain by use of fertlizers.
Plot 1. Stable manure plowed down.	45 tons.	$90.00	$412.04	$227.65
Plot 2. Commercial fertilizer sowed on surface at planting time.	Dissolved S. C. rock, 1392 lbs. Dried blood 744 lbs. Muriate potash, 448 lbs. Nitrate of soda, 452 lbs.	$44 32	$383 07	$244.36
Plot 3. Commercial fertilizer plowed down.	Same as plot 2.	$44.32	$425.69	$287.08
Plot 4. Check. Received no fertilizer.			$ 94.39	

SERIES B.

The second series or series B was laid off in the spring of 1903 and was the outcome of the fact that a comparison of the plots on series A could scarcely be fair on account of there being no relation either between the amounts or the value of the plant food in the ingredients supplied to the several plots. Series B was upon the same kind of land as series A and had been in sod the same length of time. On account of the small amount of this land of nearly uniform character the nine plots contained only $\frac{1}{40}$ of an acre each. Plot 1 received 15 tons stable manure per acre plowed down in the spring. Plot 2, check, received no fertilizer. Plot 3 received commercial fertilizer to approximate in actual plant food the amounts in the stable manure applied to plot 1. This was plowed down in the spring. Plot 4 received the same amount of fertilizer as plot 3 only it was applied and harrowed in after the ground was prepared for planting. Plot 5, check, received no fertilizer. Plot 6 received 750 pounds of commercial fertilizer plowed down in the spring. Plot 7 received the same as plot 6, but it was applied and harrowed in after the ground was prepared for planting. Plot 8 received six tons of stable manure per acre plowed down in the spring. This would supply about the same amount of plant food per acre, except in phosphoric acid, as is supplied by the 750 lbs. of fertilizer in plots 6 and 7. Plot 9, check, received no fertilizer.

This series of plots contained a strip of gravel and because of the probability of variation in character three plots were used as checks. The manure and fertilizer to be plowed down were applied and the plots were all plowed on April 23. They were occasionally harrowed until July 10, when plots 4 and 7 were top dressed with commercial fertilizer. On July 27, Premium Flat Dutch cabbage was planted. This

Cabbage on Check Plot Series B, 1907.
(Part of plot 4 in upper left hand corner).

crop was harvested November 7 and the results per acre are given in table III which also shows the amounts and value of manure and fertilizer applied, the yield and value of the crop at one-half cent per pound and the gain or loss on the fertilized plots compared with the check plots.

Table III. Records of Series B, 1903—Cabbage. Shows per Acre the Amount and Cost of Manure and Fertilizer Applied, the Yield and Value of the Crop and the Gain or Loss of Fertilized Plots Compared with Check Plots.

Plot number and treatment.	Amount of Fertilizer.	Yield in pounds.	Value of crop.	Value of fertilizer used.	Gain for fertilizers.
1 Stable manure plowed down April 23.	15 tons per acre.	16,320	$81.60	$30.00	9.20
2 Check, received no fertilizer.		11,800	59.00		
3 Commercial fertilizer plowed down April 23	Dis. S. C. rock, 600 lbs. Dried blood, 1000 lbs. Mur. of potash, 250 lbs. Nitrate of soda, 300 lbs.	22,960	114.80	39.25	33.15
4 Same as 3, sowed on surface at planting time.	Same as 3.	22,400	112.00	39 25	30.35
5 Check, received no fertilizer.		5160	25.80		
6 Commercial fertilizer plowed down.	Dis. S. C. rock, 346 lbs. Dried blood, 186 lbs. Muriate potash, 112 lbs. Nitrate of soda, 112 lbs.	15,920	79 60	11.08	38.12
7 Same as 6 sowed on surface at planting time.	Same as 6.	14,120	70.60	11.08	29.12
8 Stable manure plowed down.	6 tons per acre.	14,840	74.20	12.00	31.80
9 Check, received no fertilizer.		7000	35.00		

The gain for each fertilized plot was computed by adding together the value of crop on the two check plots nearest the fertilized plot, dividing by two and increasing this sum by the cost of fertilizer and subtracting this amount from the value of crop from fertilized plot. Plots 1, 3 and 4 were compared with the average of 2 and 5, and plots 6, 7 and 8 with the average of 5 and 9.

The crop of 1903 was harvested so very late that the land was allowed to lay bare during the winter. On March 28, 1904, the manure and fertilizers were applied on the several plots which were to have fertilizers plowed under and all the plots were plowed. On April 5, after harrowing, the remaining plots received their dressings of fertilizer, and the ground was prepared for potatoes. Furrows three inches deep were laid off 2½ feet apart and Maryland grown second crop Early Rose potatoes cut to two eyes were planted 14 inches apart.

Table IV. shows the yield of first and second grade potatoes, the value of the crop at 60 cents per bushel for first grade and 15 cents per bushel for second grade, the value of fertilizer used on the different plots and the gain in value of products from fertilized plots over the check plots.

Table IV. Shows Yield of Potatoes in 1904 in Series B, Value of Crop, Value of Fertilizers used and Gain of Fertilized Plots over Check Plots.

Plot.	1st grade lbs.	2nd grade lbs.	Value of crop.	Value of fertilizer used.	Gain from fertilizers.
1	11680	2480	$123.00	$30.00	$50.65
2	4960	2680	56.30	.....	....
3	13600	3360	144.40	39.25	62.80
4	11840	3400	126.90	39.25	45.30
5	2040	3200	28.40	.....	.....
6	7040	3320	78.70	11.08	47.22
7	7040	2360	76.30	11.08	44.82
8	7040	3000	77.90	12.00	45.50
9	600	2560	12.40	.....	.....

The poor showing on plot 9 was due to water soaked soil, this being the lowest plot.

Crimson clover was sown after the potatoes were harvested.

By May 16, 1905, the crimson clover had made such a rank growth as to make it very difficult to properly apply and plow down manure and fertilizer. For this reason the clover was plowed under. The clover apparently decayed rapidly and the manure and fertilizers were applied to the plots to be plowed down on June 26, and all of the plots were plowed again. After several harrowings the plots 4 and 7 were top dressed with fertilizer and Autumn King cabbage was planted on July 7. This crop was harvested on November 7 and the results per acre are given in table V, which shows the yield, value of crop, value of manure and fertilizer used and the gain or loss of the fertilized plots over the check plots. The crop was valued at one-half cent per pound.

Table V. Shows the Yield per Acre of Cabbage in 1905, Series B, the Value of Manure and Fertilizer used and the Gain or Loss of the Fertilized Plots over the Check Plots.

Plot.	Yield in lbs.	Value of crop.	Value of fertilizer.	Gain for fertilizers.	Loss for fertilizers.
1	7760	$38.80	$30.00	.....	$8.80
2	3680	18.40	.....	.....	....
3	9880	49.40	39.25	.....	7.45
4	9440	47.20	39.25	.....	9.65
5	3360	16.80	.....	.....	....
6	6400	32.00	11.08	7.62	....
7	8080	40.40	11.08	16.02	....
8	9080	45.40	12.00	20.10	....
9	1960	9.80	.....	.....	....

Cabbage on Plot 4, Series B, 1907.

The plots were again left bare through the winter, and wishing to note the residual effect of the manure and commercial fertilizer, neither was applied in 1906. All plots were plowed April 6 and planted to Green Mountain potatoes. The season was very wet and the crop harvested was very poor on account of so many tubers decaying. Table VI gives the yield per acre of merchantable and unmerchantable crop, the value of the merchantable portion at 60 cents per bushel for

first grade and 15 cents per bushel for second grade, the value of the crop and the gain of fertilized plots over check plots.

Table VI, Series B, 1906. Shows Yield per Acre of Merchantable and Unmerchantable Potatoes, the Value of Crop and the Gain of Fertilized Plots over Check Plots.

Plot.	Merchantable lbs.	Unmerchantable lbs.	Value of crop.	Gain for Fertilizer.
1	9520	1440	$108.80	$86.60
2	2920	680	30.90	.....
3	2600	800	28.00	5.80
4	3760	640	39.20	17.00
5	1160	760	13.50	.....
6	1320	440	14.30	4.45
7	1160	400	12.60	2.75
8	1200	320	12.80	2.95
9	560	240	6.20	.....

This crop was practically a failure. The heavy rains in August were no doubt responsible for the results. Plot 1 had much less rot than any of the others.

Rye was sown after the potatoes were dug in 1906.

About the third week in April, 1907, one square yard of rye in each plot was cut, measured and weighed, with the following results calculated per acre.

Plots.	Weight lbs.	Height: feet.	inches.
1	14520	2	6
2	12100	2	3
3	14520	2	6
4	15125	2	6
5	7260	1	6
6	10890	1	9
7	11505	1	10
8	10285	1	10
9	4840	1	6

On May 2, 1907, the manure and fertilizer to be plowed under were applied and all the plots were plowed turning under the rye. On July 8 the fertilizer was applied to plots 4 and 7 and the ground was prepared for planting. On July 10 all plots were planted with Landreth's Large Late Flat Dutch cabbage. The growing season, while being very moist and rainy, was free from heavy floods of rain. A good crop resulted and was harvested on October 10. Table VII shows per acre the yield and value of the crop at one-half cent per pound, the value of the fertilizer used and the gain of the fertilized plots over the check plots.

Table VII, Series B. Shows the Yield of Cabbage per Acre, the Value of Crop, the Value of Fertilizer used and the Increased Yield of Fertilized Plots over Check Plots.

No.	Yield lbs.	Value of crop.	Value of Fertilizer used.	Gain for Fertilizer.
1	31640	$158.20	$30.00	$61.70
2	16800	84.00	.....	.....
3	33040	165.20	39.25	59.45
4	31136	155.68	39.25	49.93
5	9800	49.00	.....	.....
6	23968	119.84	11.08	56.96
7	23520	117.60	11.08	54.72
8	19040	95.20	12.00	31.40
9	10920	54.60	.....	.....

The result of series B for the five years 1903-4-5-6-7 are assembled and shown in table VIII. The total value per acre of the five crops harvested, the total value of the manure and fertilizer used and the total gain of the fertilized plots over the check plots are given.

Table VIII, Series B, 1903-4-5-6-7. Shows Total Value per Acre of the Five Crops from Each Plot, Total Value of Manure and Fertilizer Used and the Gain for the Fertilized Plots.

No.	Value of five crops.	Value of fertilizer.	Gain for fertilized plots.
1	$510.40	$120.00	$199.35
2	248.60	......	......
3	501.80	157.00	153.75
4	480.98	157.00	132.93
5	133.50	......	......
6	324.44	44.32	154.37
7	317.50	44.32	147.43
8	305.50	48.00	131.75
9	118.00	.....	......

SERIES C.

Series C was begun in 1904. The object of this series was to test stable manure with commercial fertilizers both in the form of chemicals like dissolved South Carolina rock, nitrate of soda and muriate of potash and in such waste animal products as raw bone, dried blood, etc. Some truckers believed that animal refuse was superior to chemicals as fertilizers.

Three stable manure plots were included to demonstrate the most economical method for the truckers to follow with manure purchased and hauled from the city.

Land of the same character as series A and B was selected for this work. The ground had been planted several years before to apple trees, had been cultivated and for three or four seasons had been enriched by plowing under crimson clover. Two years previous to the commencement of the present experiment the apple trees were removed and field corn was planted. The next season stable manure was applied and sweet corn planted.

Nine plots of one-fortieth of an acre were in this series and were treated as follows, all amounts of manure and fertilizers being stated at the per acre rate.

Plot 1—20 tons of stable manure fresh from the horse barn spread evenly over the plot in the winter.

Plot 2—20 tons of the same manure at the same time thrown into a pile and turned occasionally so as not to fire fang.

Plot 3—20 tons of stable manure at the same time thrown into a pile but not disturbed until time to plow in the spring.

Plot 4—Check, no fertilizer.

Plot 5—Chemical fertilizers to equal the amount of plant food in the 20 tons of manure; 880 pounds dissolved South Carolina rock, 480 pounds muriate of potash, 1280 pounds nitrate of soda, plowed under in the spring.

Plot 6—Same as plot 5, but the fertilizers were spread on the surface and harrowed in just before the crops were planted.

Plot 7—Animal refuse fertilizers equal in amount of plant food to that used in the manure and chemical fertilizer plots. This was plowed under in the spring; raw bone 600 pounds, dried blood 2000 pounds, wood ashes 4000 pounds.

Plot 8—Received the same fertilizers as 7 but they were spread on the surface the same as on plot 6 and harrowed in.

Plot 9—Check, no fertilizer.

The manure was hauled to the plots on February 11, 1904, and was spread over plot 1 on that date.

The piles of manure placed on plots 2 and 3 at that time were spread on April 14. Plots 5 and 7 were dressed with fertilizers on April 14 and all of the plots were plowed. On May 3 the fertilizers were spread over plots 6 and 8 and harrowed in.

One-half of each plot was at once planted to peas, onions, lettuce, tomatoes and sweet corn. There was a poor irregular stand of these crops and no results were obtained except that the fertilized plots did a little better than the checks.

On July 14 the other half of each plot was plowed and planted to McCormick potatoes. The potatoes did well and were dug October 31 with the results per acre shown in table IX. The first grade potatoes are valued at 60 cents per bushel and the second grade at 15 cents per bushel.

Table IX, Series C, 1904. Shows Amount and Value per Acre of Manure and Fertilizer Used, the Yield of First and Second Grade Potatoes and Value of Same, and the Loss for Fertilized Plots over Check Plots.

	Yield first grade.	Yield second grade.	Value of crop.	Value of Fertilizer.	Loss for Fert'z'r
Plot 1. 20 tons per acre manure spread in winter.	5520	1840	$59.80	$40.00	$50.20
Plot 2. 20 tons manure piled and turned.	7200	1760	$76.40	$40.00	$33.60
Plot 3. 20 tons manure piled, not turned.	7360	1520	$77.40	$40.00	$32.60
Plot 4. Nothing.	6560	1760	$70.00	.....	.....
Plot 5. Dissolved S. C. rock, 880 lbs. Muriate of potash, 480 lbs. Nitrate of soda, 1280 lbs. Plowed under.	6080	1360	$64.20	$44.00	$49.80
Plot 6. Same as 5, sowed on the surface.	6160	1680	$65.80	$44.00	$45.20
Plot 7. Raw bone, 600 lbs. Dried blood, 2000 lbs. Wood ashes, 4000 lbs. Plowed under.	6840	1520	$72.20	$72.00	$66.50
Plot 8. Same as 7, sowed on the surface.	4880	1520	$52.60	$72.00	$86.60
Plot 9. Nothing.	6320	1600	$67.20	.....	.....

In 1905 the manure was hauled to the plots on January 1. On April 3 the manure piles were spread on plots 2 and 3 and the fertilizers on plots 5 and 7 and all of the plots were plowed. On April 18, the fertilizers were broadcasted over plots 6 and 8 and after harrowing it in all plots were planted to "Best Early" garden peas. These were harvested as they matured.

Table X shows per acre the yield and value of peas, the value of the manure and fertilizer used and the loss per acre on the fertilized plots.

Table X, Series C, 1905. Shows per Acre the Yield and Value of Peas, the Value of Manure and Fertilizer used and the Loss of Fertilized Plots Compared with Check Plots.

No.	Yield in bushels.	Value at $1.00 per bu.	Value of fertilizers.	Loss for fertilizer.
1	40.8	$40.80	$40.00	$30.90
2	43.6	43.60	40.00	28.10
3	34.5	34.50	40.00	37.20
4	31.7	31.70	.....	.....
5	26.4	26.40	44.00	49.30
6	22.5	22.50	44.00	53.20
7	19.3	19.30	72.00	76.50
8	29.7	29.70	72.00	66.10
9	23.8	23.80	.....	.....

After the peas were all off the plots were plowed and on July 8 were planted with McCormick potatoes. Table XI gives the yield per acre of first grade and second grade potatoes and the value of the crop at 60 cents per bushel for first grade and 15 cents for second grade, and the gain in money value of the fertilized plots over the check plots.

Table XI, Series C, 1905. Shows Yield per Acre of First Grade and Second Grade Potatoes, the Value of the Crop and the Gain of Fertilized Plots.

Plot.	Yield in first grade.	Pounds second grade.	Value of crop.	Gain for fertilized plots.
1	13720	1480	$140.90	$39.90
2	11800	1000	120.50	9.50
3	11160	1020	114.15	3.15
4	11000	400	111.00	.....
5	11280	760	114.70	3.70
6	11680	720	118.60	7.60
7	11400	720	115.80	10.50
8	12000	1080	122.70	17.40
9	10240	1160	105.30	.....

These plots having had such a large amount of manure and fertilizer applied in 1904 and 1905, none was added in 1906. The plots were all plowed in April, 1906, and planted with Paragon tomatoes. Table XII gives the yield per acre, the value of crop at one-half cent per pound, and the gain for the fertilized plots.

Table XII, Series C, 1906. Shows Yield of Tomatoes per Acre, Value of Crop and Gain for Fertilized Plots.

Plot.	Yield in Pounds.	Value of Crop.	Gain for Fertilized Plots.
1	9380	$46.90	$ 6.65
2	13900	69.50	29.15
3	14720	73.60	33.25
4	8070	40.35	.....
5	13600	68.00	27.65
6	16600	83.00	42.65
7	14180	70.90	35.60
8	14340	71.70	36.40
9	7060	35.30	.....

In 1907 manure was again applied at the same rate per acre and under the same conditions as in 1904. On May 17 the commercial fertilizers were applied to the plots 5 and 7 and all of the plots were plowed. A change was made in substituting the carbonate of potash for wood ashes in plot 7.

Plots 6 and 8 were top-dressed with fertilizer on July 9 and after being harrowed all of the plots were planted to Perfection Savoy cabbage. The cabbage was harvested on October 29.

Table XIII gives the yield per acre and value of the crops at one-half cent per pound, the cost of the manure or commercial fertilizer and the gain or loss of the fertilized plots.

Table XIII, Series C, 1907, Shows Yield and Value of Cabbage per Acre, Value of Fertilizer used and Gain or Loss of Fertilized Plots.

Plot.	Yield of Crop.	Value of Crop.	Value of Fertilizer.	Gain of Fertilized Plots.	Loss of Fertilized Plots.
1	30520	$152.60	$40.00	.....	$1.40
2	38320	191.60	40.00	37.60	....
3	38000	190.00	40.00	36.00	....
4	22800	114.00	.....	.....	....
5	39920	199.60	44.00	41.60	....
6	39480	197.40	44.00	39.40	....
7	38400	192.00	72.00	25.00	....
8	36720	183.60	72.00	16.60	....
9	19000	95.00	.....	.....	....

The results of the five crops grown in the four years 1904 to 1907 inclusive, are shown in table XIV. In this table are given the total value of all of the crops grown on each plot, computed per acre, the total cost of manure or fertilizer and the total gain or loss per acre from the use of manure or fertilizer. The figures show that it is not profitable to use such large amounts of fertilizing materials.

Table XIV, Series C, 1904 to 1907. Shows Total Value per Acre of Five Crops, Total Value of Manure and Fertilizer used and Total Gain or Loss of the Fertilized Plots.

Plot.	Value of Five Crops.	Value of Fertilizers.	Gain of Fertilized plots.	Loss of Fertil'd plots.
1	$441.00	$120.00	.....	$35.95
2	501.60	120.00	$14.55	.....
3	489.65	120.00	2.60	.....
4	367.05	......	.....	.....
5	472.90	132.00	.....	26.15
6	487.30	132.00	.....	8.77
7	470.20	216.00	.....	71.90
8	460.30	216.00	.....	82.30
9	326.60	.....	.....	.....

SERIES D.

Series D, started in 1902, is a comparison of commercial fertilizer and manure on sweet potatoes.

After some preliminary work from 1899 to 1902 inclusive, which seemed to indicate that just as good results could be obtained by using chemical fertilizers as by using barn-yard manure in the production of sweet potatoes, Series D was started.

The plan was to have three plots and to treat one with stable manure, one with commercial fertilizer and the other to be untreated for a check plot.

That the cumulative effects of the manure and fertilizer might be noticed the sweet potato was to be the crop planted year after year without a change, and as its effect upon the soil was and is still an interesting question it was thought that this might prove of value.

The original plots of $\frac{1}{20}$ of an acre each selected for this experiment, were a light yellow loam with a yellow clay subsoil. These plots were quite fertile having been heavily manured for sweet potatoes and other truck crops for several seasons. In 1902, unavoidable circumstances made necessary a change in the location and the work was moved a short distance to the present plots of the same size and character of soil as the original plots. These new plots were not as fertile as the old ones because no stable manure had been applied for several years. For a number of years previous to 1901 fruit trees occupied this land.

A careful study should be made of the tabulated data following as the amounts of manure and formulas of the fertilizers were changed whenever such change seemed warranted in order to secure best results. No attempt was made in series D, as in Series A, B and C, to use commercial fertilizer in such amounts that its analysis would be the same as that of manure. The aim was to supply plenty of potash and this in the form of sulphate which is always recommended for sweet potatoes.

Table XV shows the amounts of manure and commercial fertilizer per acre used each season and the per cent. of nitrogen, phosphoric acid and potash they contained; the yield of primes, seconds and culls per acre and the value of the crop at 50 cents per bushel of 55 pounds for primes, 25 cents for seconds and 10 cents for culls; the value per acre of the manure and fertilizer and the gain or loss per acre of the fertilized plots.

Table XV, Series D, 1899 to 1907. Shows per Acre Amount and Analysis of Manure and Fertilizer Used, the Yields of Primes, Seconds and Culls and Value of Crop, and the Gain or Loss of Fertilized Plots Compared with Check Plot.

			AVAILABLE				YIELD					
Plot	Season	Manure or Fertilizer	Nitrogen Per Ct.	Potash Per Ct.	Phos. Acic Per Ct.	Value of Fertilizer	Primes Bushels	Seconds Bushels.	Culls Bushels.	Value of Crop. $	Gain for Fertilizer. $	Loss for Fertilizer. $
1	1899	Manure, 15 tons	4-5	5-6	2-3	$30.00	200.5	61.4	56.5	121.25	30.60	
2	"	Check					77.8	71.5	38.8	60.65		
3	"	Dis. S. C. rock, 225 lbs.			8-9							
		Dried fish, 225 lbs.	2-3									
		Sulfate of potash, 150 lbs.		12-13		8.80	219.5	63.2	54.7	131.02	62.57	
1	1900	Manure, 15 tons	4-5	5-6	2-3	30.00	131.0	18.1	15.1	71.53	1.92	
2	"	Check					72.6	6.0	18.1	39.61		
3	"	Dis. S. C. rock, 255 lbs.			8-9							
		Dried fish, 225 lbs.	2-3									
		Sulfate of potash, 120 lbs.		10-11		18.00	100.0	18.1	15.1	56.03	8.42	
1	1901	Manure, 20 tons	4-5	5-6	2-3	40.00	130.0	2.13	43.3	74.65	9.19	
2	"	Check					44.4	8.1	12.4	25.46		
3	"	Dis. S. C. rock, 240 lbs.			8-9							
		Dried fish, 240 lbs.	2-3									
		Sulfate of potash, 120 lbs.		10-11		8.10	105.4	17.3	42.3	61.25	27.69	
1	1902	Manure, 15 tons	4-5	5-6	2-3	30.00	190.0	46.2	30.0	109.55	4.14	
2	"	Check					126.2	36.4	32.1	75.41		
3	"	Dis. S. C. rock, 330 lbs.			7-8							
		Dried blood, 150 lbs.	2-3									
		Sulfate of potash, 120 lbs.		10-11		7.62	129.4	28.2	28.4	74.39		8.64
1	1903	Manure, 10 tons	4-5	5-6	2-3	20.00	116.0	26.4	19.1	66.51	10.26	
2	"	Check					54.2	27.2	23.5	36.25		
3	"	Dis. S. C. rock, 240 lbs.			6-7							
		Dried fish, 240 lbs.	2-3									
		Sulfate of potash, 120 lbs.		10-11		6.90	91.3	18.3	14.1	51.63	8.48	
1	1904	Manure, 10 tons	4-5	5-6	2-3	20.00	103.0	18.1	13.2	57.84		3.12
2	"	Check					66.0	24.2	19.1	40.90		
3	"	Dried fish, 360 lbs.			7-8							
		Nitrate of soda, 120 lbs.	7-8									
		Sulfate of potash, 120 lbs.		10-11		9.90	91.0	18.3	14.1	51.48	62.0	
1	1905	Manure, 5 tons	4-5	5-6	2-3	10.00	109.0	30.2	20.1	64.05	28.65	
2	"	Check					40.0	14.0	19.0	25.40		
3	"	Dried fish, 495 lbs.			9-10							
		Nitrate of soda, 35 lbs.	6-7									
		Sulfate of potash, 70 lbs.		5-6		8.55	92.0	29.1	20.2	55.29	11.34	
1	1906	Manure, 5 tons	4-5	5-6	2-3	10.00	115.0	55-2	31.4	74.44	28.69	
2	"	Check					34.0	62.0	32.5	35.75		
3	"	Dried fish, 360 lbs.			7-8							
		Nitrate of soda, 120 lbs.	7-8									
		Sulfate of potash, 120 lbs.		10-11		9.90	84.0	45.2	31.3	56.43	10.78	
1	1907	Manure, 6½ tons	4-5	5-6	2-3	13.00	74.0	12.2	18.4	41.89	5.35	
2	"	Check					36.0	15.3	17.2	23.54		
3	"	Dis. S. C. rock, 400 lbs.			9-10							
		Nitrate of soda, 320 lbs.	8-9									
		Sulfate of potash 180 lbs.		14-15		13.25	53.0	16.0	16.2	32.10		4.67

For the first three years the results were clearly in favor of the commercial fertilizer, but after moving the experiment to the other

plots this is not the case. These results would, however, tend to strengthen the opinion expressed before that a combination of stable manure and commercial fertilizers would in all probability be the best. It is clear, moreover, that the smaller quantity (5 tons per acre) of stable manure produced almost as large a crop and gave much greater profits than larger applications of manure. While it does look as though the yield is steadily decreasing, this may not really be the case, because the plots are in a rather low situation where the plants have to be set late in the spring and the crops harvested early in fall on account of frost, and the last three seasons have been especially unfavorable in this respect.

Diseases do not appear to have increased from continuous planting of the crop on the same land, in fact, the last crop was almost free from any disease.

DISCUSSION OF RESULTS.

In order to determine from all of the tables thus far given the comparisons of manure vs. commercial fertilizer, and commercial fertilizer plowed under, vs. top dressing with it after the ground is plowed, etc., it is necessary to assemble the results from plots treated similarly throughout the different series.

Comparison of stable manure vs. commercial fertilizer. The following figures are obtained by averaging the results per acre from the best plots of Series A and B.

Manure (average of heavy and light applications) gain over check plots $186.25.

Commercial fertilizer (average of heavy and light applications) gain over check plots—$198.40.

There is thus a gain per acre of $12.15 for the commercial fertilizer.

Comparison of plowing down commercial fertilizer vs. applying it on plowed ground as top dressing harrowed in just before crop was planted. The following is an average of the results per acre in Series A and B.

Commercial fertilizer plowed down, gain over check plots $198.40.

Commercial fertilizer top-dressing on prepared land, gain over check plots $174.90.

This comparison shows a gain per acre of $23.50 in favor of plowing down the fertilizer. By referring back to the tables showing the annual crops, it will be noticed that these gains are mostly obtained by the better yields when cabbage was the crop planted. The potato crops did not seem to be affected to such an extent. This, however, would not justify the inference that cabbage should have the fertilizer plowed down and potatoes should not, because in the season of 1905 the result on Series B shows the gain to be in favor of plot 7 upon which the fertilizer was sown on top just before cabbage was planted. From the experience in this work and other observations without hav-

ing made any specific experiments it would seem fair to infer that the difference in favor of plowing down the fertilizer, may be attributed to the length of time the application had been made before the crop was planted, for in the case of the potatoes the crop was planted shortly after the fertilizer was plowed down, while the cabbage was not planted until six to ten weeks had elapsed except in the season of 1905 when the fertilizer plowed under was applied only two weeks before the surface dressing was done. The fertilizing materials when applied some time before crops are planted no doubt become well distributed throughout the soil, and probable aid in bringing about many beneficial changes.

Comparisons of heavy and light applications of commercial fertilizers. These results are averages per acre from series A and B. Commercial fertilizer, heavy application, 2150 lbs. per acre, gain over checks $153.75.

Commercial fertilizer, light application, 750 lbs. per acre, gain over checks $220.72.

The gain for the light application is $66.97. If series B alone were taken to make this comparison the difference would not have been quite as great. This work seems to justify the conclusion that 750 pounds of commercial fertilizer per acre annually is more profitable than three times that amount on the kind of soil used and under the conditions that prevailed during the years in which the test was conducted.

Comparison of heavy and light applications of stable manure.—These results are averages per acre from series A and B. Heavy application—15 tons per acre—gain over checks $213.50. Light application—6 tons per acre—gain over checks $131.75.

The gain for the heavy application is $81.75 per acre. This bears out to some extent what has long been the practice of farmers. There is no doubt, however, that much stable manure is wasted and if lighter dressings supplemented with commercial fertilizers were used, the results would be better.

Comparison of fresh and rotted stable manure.—These results were obtained from five crops on series C, the crops being in the order given: Potatoes, peas, tomatoes, potatoes and cabbage. Fresh manure 20 tons per acre, net loss $35.95 per acre compared with check plots. Rotted manure 20 tons per acre, net gain $14.55 compared with checks.

For these crops the rotted manure was the most desirable. This is probably in some measure due to the greater availability of the plant food in the rotted manure. Since the fresh manure was applied in the winter it might be possible that some of the plant food was carried away by heavy rains on a frozen surface. Also, at the time of plowing in the spring the strawy parts of the fresh manure were in a perfectly unbroken and almost unchanged form while the strawy portion of the rotted manure was at least partly available as plant food.

Comparison of rotted manure which was turned vs. that unturned in the process of decay. These results are the average per acre of five crops on series C.

Rotted manure, turned, gain per acre over checks $14.55.

Rotted manure, unturned, gain per acre over checks, $2.60.

The experiment shows that it pays to turn manure while in process of decaying. The operation not only prevents some loss of plant food, but it mixes and distributes the strawy bunches through the pile, so that, when ready to be spread the whole pile is in uniform condition.

Comparison of commercial fertilizer derived from mineral sources vs. those derived from animal and vegetable sources. This is the average per acre of three crops in series C.

Mineral fertilizers, net gain per acre over checks $54.20.

Organic fertilizers, net gain per acre over checks $47.20.

By taking the three profitable crops on series C and averaging the results as above, the mineral fertilizers are shown to be the most profitable. On the other hand, if the comparisons are made between the plots the two seasons that the dependence was on the residue left in the soil, the organic fertilizer plots gave the greater profit. The common practice of combining the two is no doubt the correct one.

REVIEW AND CONCLUSIONS.

In reviewing the above work as a whole there would seem to be some contradictions. In series A and B the plowed down plots were invariably in the lead. In series C, however, this was not the case for only in one season did the plots treated this way give a slightly increased yield.

Also in Series A and B the fertilizer and manures whether sowed on the surface or plowed down made gains enough to show a handsome profit. In Series C, plot 1, a manure plot was worked at a loss and all the commercial fertilizer plots were very much behind.

Considering the series separately it would seem that series A had been operated for the greatest gain. This was helped considerably by the hay crop which came in as a catch crop and left the land so that a good crop of cabbage followed. One fact to be noted is that on Series A there was no greater profit from the application of 15 tons of manure per acre than from the application of 750 lbs. of commercial fertilizer costing only one-third as much, without regard to the cost of applying which is in itself an expensive item.

The figures in the tables while being relatively all right for comparison cannot be taken as being absolutely as correct as if all the crops were sold and accounts kept. There is no doubt that if everything had been sold the check plots would not have stood so high as they do in most cases, especially the cabbage crops, because the grade of the stock grown was very poor.

The tests on series C, as to the best manner for the market gardener to handle his manure, did not turn out as was expected when viewed from the standpoint of what is considered the best farm practice. It has been advocated for some time that the farmer would better get his manure out on the land as soon as possible to avoid waste. This

may be true when corn is the principal crop grown and sod land available upon which to spread the manure, but in vegetable growing it seems to be necessary to subject the manure to some treatment that the strawy part may be decomposed and become available as plant food. The table shows that plot 2 upon which the manure was turned to prevent burning, was the most profitable plot and next to this in profit was plot 3 upon which the manure was piled and not turned.

Regarding the question of mineral fertilizers as against the animal waste fertilizers, the results show that crops were just as good and indeed generally a little better where the mineral fertilizers were used. The land does not appear to have suffered in any respect from their use.

If we take a summary of the whole of the series it will not be very apparent that any benefit was derived from plowing down the fertilizer; neither was there any waste from doing so.

It would appear from the above work that for such crops as those used, the larger amounts of manure cannot be profitably applied.

In series C, there was a loss in using 20 tons of manure or its equivalent in commercial fertilizers.

Series A, was quite profitable and the 750 pounds per acre of fertilizer gave very nearly as large yields as larger applications and considerable more profit.

Seven hundred and fifty pounds of commercial fertilizer on series B, also did well, and the use of six tons of manure always gave about the same yield.

From this work and other experiments and observations it seems necessary to put the land in grass every few years if summer crops are to be grown. Late cabbage especially does not do well on land that has been cropped every year; but if a piece of sod land, even if somewhat thin, can be given 750 lbs. of commercial fertilizer with a light dressing of stable manure, it will invariably produce a good crop. The application of a great deal of manure and fertilizers seems to bring about a condition that in seasons of excessive rains coupled with much heat, is very detrimental to the growth of plants which are natives of a temperate climate.

SUMMARY.

Stable manures always increased the yields, but valued at $2.00 per ton did not give as much profit as commercial fertilizer.

Fresh manure spread in winter did not give as much increase as the same amount rotted and plowed down at same date in the spring.

Turning the manure while rotting was better than leaving it without being turned.

Commercial fertilizers plowed under in the spring invariably gave larger yields than when sowed on the surface just before planting in the summer.

About 750 pounds of commercial fertilizers seemed to be more profitable than three times that amount.

Continuous crops of sweet potatoes on same land does not appear to be bad practice.

The quality of the crops, cabbage and potatoes especially, grown upon the check plots, was of very poor grade.

The soil on plots heavily dressed with mineral fertilizers does not seem to have been changed or injured any more than where the organic fertilizers were applied.

The seasons through which this work has been followed have all been very moist and some were quite wet.

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MISCELLANEOUS GREENHOUSE NOTES.

By C. P. Close, Thos. H. White and W. R. Ballard.

INTRODUCTION.

During the past eight years various lines of interesting work have been carried on in the greenhouse, but as there was not at any time enough material under any one subject to justify publishing in bulletin form, the results have accumulated until it seems desirable now to include everything in brief form in one report. Mr. Thos. H. White has had charge of all this work since its inception. Prof. W. N. Hutt and Mr. S. B. Shaw are hereby given credit for assistance and suggestions on these lines of work while they were connected with this Experiment Station.

FERTILIZER IN SOLUTION ON CHRYSANTHEMUMS AND LETTUCE.

In Bulletin No. 81 of this Experiment Station, are recorded some experiments conducted in previous years with fertilizers in solution on chrysanthemums. The work showed that the plain cow excrement was of very little value as a stimulant or as it is more commonly called a "food" for the chrysanthemums, in producing blooms of large size and of good finish. This was not the case, however, with the urine of the animal. This, when supplemented with phosphates, seemed to give very good results.

There was also some work done with chemical fertilizers in solution, enough being used to approximate the amounts of nitrogen, phosphoric acid and potash found in the animal urine. The work as planned in the above bulletin has been continued and the results follow.

Several formulas were used in this work and these were changed or added to as circumstances seemed to warrant. Table I shows the formulas and quantities of each of the several things used and the number of seasons tried. The nitrate of potash was put into the experiment because it was thought that this material, being almost pure nitrogen and potash, might be very much better for greenhouse work

than nitrogen and potash in other combinations. This did not prove to be the case, however, so that it was dropped. The sheep manure water has been tried three seasons and has apparently done a little better than either of the other mixtures. The cow urine and dissolved S. C. rock, and the muriate of potash, nitrate of soda and dissolved S. C. rock mixtures, have been used the most and have given good results. The flowers upon the plot receiving the chemicals have been quite as good and sometimes a little better than upon the plot receiving the cow urine.

With regard to the sheep manure, there is of course a certain amount of fiber that becomes mixed in the water even though the material is placed in a coarse sack and suspended in the water in this manner. After a few waterings this fibrous matter forms a light mulch over the surface, which seems to induce healthy and vigorous root development upon the surface of the soil. This is rarely seen where the chemicals are used and it may be that this would account for the somewhat better results secured upon this plot. The chemicals, however, are so easily obtained and are so readily soluble and odorless, a feature which would be quite a recommendation in some places, that they should be used in preference to the liquid animal manures. . If it was thought worth while, a light mulch of well rotted manure, used in connection witih the chemicals, should secure about the same results.

Table I. Shows Kind of Fertilizers in Solution Used on the Plots for Five Years and the Weight and Number of Chrysanthemum Blooms and the Length of the Stems Produced.

Year.	PLOT 1. Cow urine and dis. S. C. rock.			PLOT 2. Nit. of soda, muriate of potash and dis. S. C. rock.			PLOT 3. Nothing.			PLOT 4. Dried blood, dis. S. C. rock and muriate of potash.			PLOT 5. Sheep manure and dis. S. C. rock.			PLOT 6. Nitrate of potash and dis. S. C. rock.		
	Blooms.			Blooms.			Blooms.			Blooms.			Blooms.			Blooms.		
Year.	Weight. oz.	Size. inches.	Length of stem. inches.	Weight. oz.	Size. inches.	Lentgh of stem inches.	Weight. oz.	Size. inches.	Length of stem inches.	Weight. oz.	Size. inches.	Length of stem inches.	Welght. oz.	Size. inches.	Length of stem inches.	Weight. oz.	Size. inches.	Length of stem inches.
1902	48	....	......	46	....	......	43	....	......	....	....	......	....	....	......	50	....	......
1003	29	....	......	26	....	......	24	....	......	....	....	......	....	....	......	28	....	......
1904	66	....	......	79	....	......	50	....	......	60	....	......	57	....	......	....	....	......
1905	67	5.3	34.8	75	5.5	34.8	69	4.9	39.6	64	4.9	36.0	72	5.4	37.2	....	....	......
1906	68	5.0	38.4	75	5.3	33.6	47	4.7	33.6	66	5.3	34.8	77	5.6	38.4	....	....	......
Average.	55	5.2	36.6	60	5.4	34.1	46	4.8	36.6	63	5.1	35.4	68	5.5	37.8	39	....	......

RESIDUAL EFFECT OF FERTILIZER SOLUTION ON LETTUCE.

In the rotation used in the greenhouse, lettuce invariably followed the crop of chrysanthemums and it was thought well to keep a record of the several plots that had been used in the "fertilizers in solution experiment," to note what effect the fertilizer remaining in the soil would have upon the succeeding crop. The records of the lettuce are given in Table II, and the results in the main correspond with those obtained in the chrysanthemum work.

Table II. Shows the Kind of Fertilizer Used on Each Plot and Yield of Lettuce on Each Plot.

Year.	Crop.	Plot 1. Cow urine and dissolved S. C. rock, (8 gallons of urine to one pound of rock)	Plot 2. Nitrate of soda, muriate of potash and dissolved S. C. rock.	Plot 3. Nothing.	Plot 4. Dried blood, muriate of potash and dissolved S. C. rock.	Plot 5. Sheep manure and dissolved S. C. rock.	Plot 6. Nitrate of potash and dissolved S. C. rock.	Plot 7. Cow urine, (8 gallons to 48 gallons of water.)	Plot 8. Sulfate of ammonia, muriate of potash and dissolved S. C. rock.	Plot 9. Sheep manure.	Plot 10. Nitrate of soda and muriate of potash.
		Weight, ounces	Weight, ounces.	Weight. ounces.	Weight, ounces.	Weight, ounces.	Weight. ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.
1901	First.	135	90	72	....	....	....	120	75	....	....
1902	"	....	....	52	....	....	....	62	....	....	82
	Second.	....	....	40	....	....	....	51	....	....	70
1903	First.	23	21	22	....	....	23	....	....	....	....
	Second.	50	76	19	....	....	77	....	....	....	....
1904	First.	61	66	64	....	....	....	....	....	48	....
	Second.	68	69	34	....	....	....	....	....	67	....
1905	First.	14	42	12	16	21	....	....	....	....	....
1906	"	59	58	53	54	58	....	....	....	....	....
	Second.	92	90	72	62	96	....	....	....	....	....
1907	First.	42	37	23	34	44	....	....	....	....	....
	Second.	76	76	35	58	64	....	....	....	....	....
Average.......		62	62	49	45	56	50	75	75	57	76

COVER CROP SOILS FOR USE IN GREENHOUSE IN GROWING CHRYSANTHEMUMS AND LETTUCE.

The procuring of suitable soils for greenhouse work is often a source of considerable anxiety in the mind of the florist. There having been some experiments with cover crops in connection with orchard management started in the fall of 1901, it was suggested that soil from these several plots be used in the greenhouse. The orchard, before the cover crop experiment was started, had been well tilled and an annual crop of crimson clover had been disced in, or plowed under, in the spring. The orchard plots were treated as follows:

Plot 1 was seeded to white clover and left permanently, the growth being clipped two or three times each season and left upon the land. Plot 2 was plowed in sprng and kept harrowed until about August 1 when it was seeded to crimson clover to be plowed down the following spring. Plot 3 was plowed in the spring and sowed to cowpeas about the first of June, the stubble being left on the ground to be plowed down the following spring. Plot 4 was seeded to rye in the fall to be plowed under in the spring, and a crop of cowpeas grown and plowed under in the fall. Plot 5 was seeded to rye in the fall, this was plowed down in the spring and the ground was well tilled until it was seeded to rye again in the fall.

Plate I.—Chrysanthemums on Cover Crop Soils.
The plots numbering from right to left are: 1, sod compost; 2, rye; 3, crimson clover; 4, cowpeas and rye; 5, cowpeas; 6, clover sod.

In the greenhouse these soils were used in comparison with a soil of sod and manure compost such as is generally used in greenhouse work. All plots received a good dressing of cow manure except in the season of 1907. Plate I shows chrysanthemums in bloom in the cover crop plots.

Chrysanthemums with lettuce following, were used as a rotation on these plots for five years.

Table III. Shows Kind of Soil Used, Weight, Size of Bloom and Length of Stem of Chrysanthemums Produced on Six Plots for Five Years.

YEAR.	PLOT 1. SOD COMPOST. BLOOM.			PLOT 2. RYE. BLOOM.			PLOT 3. CRIMSON CLOVER. BLOOM.			PLOT 4. COW PEAS and RYE. BLOOM.			PLOT 5. COW PEAS. BLOOM.			PLOT 6. CLOVER SOD. BLOOM		
	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.	Weight, ounces.	Size, inches.	Length of stem, inches.
1903.....	36	.....	......	35	......	......	36	......	......	43	......	......	45	......	......	44	.....	......
1904.....	91	4.98	43 2	94	5 2	45.6	90	5.0	45 6	94	5.1	43 2	96	4.9	44.8	75	4.8	45.6
1905.....	65	4.8	39.6	61	4 5	36.0	75	5.1	37 2	76	5.1	34.8	72	5.2	34.8	67	4 9	34.8
1906.....	48	4 5	39.6	40	4 4	34.8	55	4.7	39.6	52	4.9	36.0	50	4.8	36.0	51	4.6	36.0
1907	48	5 1	36.0	38	4.4	32.4	34	4.6	31.2	46	4.7	32 4	48	4.9	32 4	36	4.5	28 8
Average.	57	4.87	39 6	53	4.6	37.2	58	4.8	38.4	62	4.9	36.6	62	4.9	37.0	54	4.7	36.3

In 1903 when the experiment started, only the weights of the chrysanthemums were recorded, but in the following years both the size of the blooms and the length of stems were recorded and the results are given in Table III.

The results show no remarkable difference in the plots. As a rule, however, the rye plot soil gave the poorest yields both in weight and size of flower. The foliage on this plot was usually of a light green color indicating the lack of available nitrogen in the soil. The plots with soil upon which the leguminous crops had been grown, had dark green foliage. It would seem that the value of green manures in building up and improving the soil depends to some extent upon the nature of the cover crop used. Notwithstanding the fact that rye produces a large amount of decaying organic material, its use as a green manure in the experience of the Station, has uniformly given poorer results than the other cover crops tried.

The lettuce from these greenhouse plots gave results similar to those with chrysanthemums. The yields of the various plots are given in Table IV. The sod compost gave the best results with this crop and the two cowpea soils next best. It would seem from the results of these experiments that the source of the soil is not a very important consideration for these crops if properly supplemented with manure or fertilizer.

Table IV. Shows Weight of Six Crops of Lettuce Following Chrysanthemums Produced on Soils in Greenhouse from Cover Crop Plots in Orchard.

Year.	Crop.	Plot 1. Sod compost. Weight, ounces.	Plot 2. Rye. Weight, ounces.	Plot 3. Crimson clover. Weight, ounces.	Plot 4. Cowpeas and rye. Weight, ounces.	Plot 5. Cowpeas. Weight, ounces.	Plot 6. Clover sod. Weight, ounces.
1903-4.....	First....	53	48	55	67	70	48
"	Second..	65	46	49	52	39	50
1904-5.....	First....	46	6	7	7	15	5
1905-6.....	First....	47	50	45	51	63	48
....	Second..	61	58	59	61	62	63
1906-7.....	First....	29	29	30	29	29	34
Average..	....	50	39	41	44	46	42

CHRYSANTHEMUMS AND LETTUCE—THE USE OF PHOSPHATES TO SUPPLEMENT BARNYARD MANURE.

The experiments of agriculturists and the investigations of chemists both point to the fact that in order to produce the best yields of grain crops, barnyard manure should be supplemented with some form of phosphoric acid. Experiments for years have shown that phosphoric acid usually increases the yields of such crops as wheat, oats, barley, etc. Analysis of the plant indicates that most of the phosphoric acid is in the grain or seed. The practice by florists of using large quantities of bone meal and the immensely large flowers grown as a result, tend to establish a relation between the phosphoric acid and large flowers.

To grow crops continually on solid beds in the greenhouse without change of soil but by the addition of an annual dressing of manure, it would seem necessary to supplement the manure with some form of phosphoric acid. To test this proposition a solid bed was divided into four plots and treated each year as follows: plot 1 received phosphate in an insoluble form, this being slag phosphate with the exception of one year when ground Tennessee rock was used; plot 2 received dissolved South Carolina rock; plot 3 received fine ground raw animal bone and plot 4 was the check receiving no phosphoric acid other than that contained in the barnyard manure.

The plots were annually dressed with an inch of well rotted manure and the experiment continued through seven years. The crops grown were chrysanthemums and lettuce. The soil which originally was a yellowish, smooth-feeling loam changed during the course of the experiment to a very dark color and floculated to such an extent that the particles became quite large. The amounts of fertilizers applied each year and the records of weights and measurements of chrysanthemums are given in Table V. The plots were 3x8 feet and each contained 48 plants. The varieties used were Mrs. Robinson and O. P. Bassett. The records do not show that any marked benefit was derived from the additional applications of phosphates. This was entirely different from what was expected, but can probably be accounted for by the fact that the large amount of manure applied annually supplied about 120 pounds of phosphoric acid per acre each year, this probably was nearly sufficient for the needs of the plants without the extra amounts applied in other forms. From the information at hand it would appear that well rotted barnyard manure contains considerable available phosphoric acid while the fresh manure is deficient in this respect. Thus the necessity of heavy dressings of bone meal on plants treated with liquid from fresh animal manures is explained, while soils well enriched with rotted manure do not need such heavy dressings of bone.

Lettuce was grown on the above plots after the chrsyanthemums without any further application of phosphates. The records of the weights of eleven crops are given in Table VI and the results are about the same as with the chrysanthemums.

Table V. Shows Amount and Kind of Phosphates Applied to Supplement Barnyard Manure, and Weight, Length of Stem and Size of Chrysanthemum Blooms.

YEAR.	PLOT 1.				PLOT 2.				PLOT 3.				PLOT 4.			
	Fertilizer, pounds per acre, slag phosphate.	BLOOM.			Fertilizer, pounds per acre. Dissolved S. C. rock.	BLOOM.			Fertilizer, pounds per acre, bone meal.	BLOOM.			Check, no Fertilizer.	BLOOM.		
		Weight, ounces.	Length of stem, inches.	Size, inches.		Weight, ounces.	Length of stem, inches.	Size, inches.		Weight, ounces.	Length of stem, inches.	Size, inches.		Weight, ounces.	Length of stem, inches.	Size, inches.
x1901	385	......	......	......	300	......	......	......	322	......	......	......	....	......	......	......
x1902	500	......	......	......	500	......	......	......	500	......	......	......	....	......	......	......
1903	500	81	......	......	500	83	......	......	500	76	......	......	....	72	......	......
1904	300	201	44.4	4.7	300	177	39.6	4.8	300	224	42.0	4.7	226	226	39.6	4.9
1905	500	119	30.0	4.5	500	111	30.0	4.5	500	129	34.8	4.7	....	181	34.8	4.7
1906	500	277	48.0	5.5	500	266	48.0	5.0	500	259	49.2	5.0	....	265	43.2	5.0
1907	2000	223	43.2	5.2	2000	206	42.0	5.0	2000	198	39.6	5.0	....	192	39.6	4.9
Average ..	669	180	41.6	4.9	657	168	39.9	4.8	660	177	41.4	4.8	....	187	39.3	4.9

x No weights and measurements were taken the first two years.

Table VI. Shows Weight of Eleven Crops of Lettuce Produced on Phosphate Plots Following Chrysanthemums.

Year.	Crop.	Plot 1. Weight, ozs.	Plot 2. Weight, ozs.	Plot 3. Weight, ozs.	Plot 4. Weight. ozs.
1902	First	264	327	302	274
1902–3	First	104	82	81	84
	Second	224	221	219	200
1903–4	First	150	181	172	182
	Second	191	240	234	225
1904–5	First	195	203	224	248
	Second	192	158	172	172
1905–6	First	144	134	163	144
	Second	206	224	221	235
1906–7	First	152	137	142	150
	Second	232	248	256	266
Totals....	....	2044	2155	2185	2180

CHRYSANTHEMUMS AND LETTUCE—CONTINUOUS CROPPING WITHOUT CHANGING SOIL.

In large greenhouse establishments, the work of annually removing all of the soil from the beds and benches, and replacing it with new, is an expensive item. The necessity for this has been proven by the experience of many men at various times. The reason for the necessity is rather more obscure. The grower rarely questions the fact, but goes to work and changes the soil because it is the right thing to do in order to secure the best results. He claims that without changing the soil often it will become full of disease germs, or exhausted, or sour.

The work mentioned here has been done on, and relates to, solid beds only. Plate II shows the 1903 crop of chrysanthemums on solid beds. The necessity of removing soil to get rid of disease does not seem to be borne out under the conditions prevailing here. As to becoming impoverished, annual dressings of barnyard manure and fertilizers will overcome this difficulty. The souring of the soil seems to be the worst feature to contend with. It would seem that so called "souring" could be neutralized by the application of lime, yet in practice here this could not be done. The soils that have been used in this connection were planted to cherry trees several years before the experiment was started in 1898. The upper six inches was a yellowish, smooth loam, but did not produce much growth in the cherry trees although it had been enriched annually by turning down a crop of crimson clover. The soil was gathered in August and composted with rotted manure.

This was placed in the beds in October and lettuce was planted. The lettuce was a complete failure by not only refusing to grow, but also by being affected with various diseases. That this was not the

fault of the temperature or other greenhouse conditions was plain, because some plots of garden soil in the same house produced good heads of lettuce comparatively free from disease. After more manure had been applied, another crop of letture was tried and yielded satisfactorily. Chrysanthemums planted the following summer were very fine as was also the lettuce which followed the chrysanthemums as a midwinter crop. The bed had an annual dressing of an inch or so of well rotted manure. One crop of chrysanthemums and two crops of lettuce have been grown each year on this soil since 1898. Plates III and IV show the appearance of the crops for the seasons of 1905 and 1906.

Plate II.—Soil used continuously without change. Mrs. Robinson's Chrysanthemums, 1903.

There has been no disease of any account and until a year ago it looked as though the soil could be used over and over. The soil has changed very much in appearance being now very dark in color and quite granulated. There are a good many small earth worms and insect larvæ present, usually seen feeding upon decaying vegetable matter. The chrysanthemums a year ago first showed signs of not having congenial conditions in the soil. The lower leaves in the late fall became spotted and fell off. Upon examination the roots were found to be of a brownish or rusty color with an entire absence of young healthy white feeders. The plants had all the appearance of being overwatered and yet the greatest care was taken in this respect, to keep the soil barely moist.

The same condition continued for the crop of lettuce following, but the second crop of lettuce did well. The chrysanthemums of the past season while making a good growth and fair flowers, seemed to be affected in much the same way.

This condition of course interferes with the profitable continuance of this plan of never changing the soil. The chemists seem unable to explain or to correct the trouble. The inference is that the conditions are similar to that found in reclaimed peat bogs where no treatment except stirring and weathering seems to have any beneficial effect. Lime both in the form of caustic and the carbonate seems to be ineffective.

As the weather gets cooler the condition of the soil seems to improve as is evidenced by the fact that the lettuce of the second crop in 1906, which was planted in February, was quite up to normal.

Plate III.—Soil used continuous'y without change. Rawson's Crumpled Leaf Lettuce, 1905.

Observations on out door work with soils which seemed to be affected in the same way, point to the fact that some particular types of plants of tropical or sub-tropical origin which are fond of heat and moisture, such as cannas, corn, caladiums, etc., do well on these soils; while cabbage, celery, lettuce and such plant, natives of a temperate climate, give much less satisfactory results. The large amount of organic matter supplied in the form of rotted manure and coupled with rapid fermentation in hot weather, probably induces excessive amounts of some chemical compound which is injurious to some plants.

These soil problems seem very difficult to solve and the grower who provides for an annual supply of fresh soil will in all probability take the safest course.

CARE OF SOLID BEDS.

Observations here and experiments at other stations show the absolute necessity of taking care of the soil in the solid beds that are to be planted the following year. If it is possible and profitable it is best to grow some crop and thus keep the soil in a suitable condition.

Where lettuce is to be grown, chrysanthemums planted in June will sell at greater profit in the fall than lettuce and the plants can be removed in time to get in the midwinter crop of lettuce. If a growing

crop cannot be used, cover with strawy manure and water occasionally through the summer, sufficiently to keep the beds moist. A moist condition is favorable to the bacterial colonies which are so valuable in making plant food available.

TESTS OF EXTRA LARGE AMOUNTS OF NITROGEN IN INFLUENCING EARLY GROWTH AND BLOOM OF CARNATIONS.

This experiment was started in the Fall of 1904 to test the stimulating effect of nitrates in different forms and in different amounts as follows:

Plot 1—Nitrate of soda at the rate of 100 pounds per acre.
Plot 2—Nitrate of soda at the rate of 200 pounds per acre.
Plot 3—Nitrate of soda at the rate of 300 pounds per acre
Plot 4—Check.
Plot 5—Dried blood at the rate of 500 pounds per acre.
Plot 6—Rotted manure at the rate of 9000 pounds per acre.

Plate IV.—Soil used continuously without change. Grand Rapids Lettuce on Solid Bed.

The variety, Mrs. Lawson, was used and the records are found in Table VII. The majority of the plots show negative results for the two seasons tried. The 300 pounds of nitrate of soda and 500 pounds of dried blood showed superiority over the check plot only in number of blooms per plant. The dried blood alone gave longest stems while the check plot had the largest flowers. There were 12 plants on each plot.

Table VII. Shows Amount of Fertilizer Applied to Each Plot, and the Average Number and Size of Blooms and Length of Stems Per Plant for 1904-5 and 1905-6.

Plot.	Fertilizer.	Blooms per plant	Size of blooms inches.	Length of stems, inches.
1	100 lbs. nitrate of soda....	15.2	2.60	17.0
2	200 " " " "	15.9	2.55	17.9
3	300 " " " "	17.4	2.65	18.0
4	Check, no fertilizer.......	15.9	2.70	18.4
5	500 lbs. dried blood........	16.5	2.60	18.9
6	9000 lbs. rotted manure...	15.2	2.60	18.4

EFFECTS OF FERTILIZER UPON THE STIFFNESS OF STEMS OF CARNATIONS.

During the seasons of 1904-5 and 1905-6, different fertilizers were used on carnations to determine the effect of nitrogen, phosphoric acid and potash on the stiffness of the stems. The first year, plot 1 received at the rate of 8100 pounds of dried sheep manure per acre. Plot 2 received 1400 pounds of dried blood, 300 pounds of sulphate of potash, and 2000 pounds of dissolved S. C. rock per acre. Plot 3 received 2000 pounds of dissolved S. C. rock. Plot 4 was a check plot. Plot 5 received 300 pounds of sulphate of potash per acre. Plot 6 received 1400 pounds of dried blood per acre. The next year the same fertilizers were used, but the amounts were doubled. The variety, Mrs. Lawson, was grown for this experiment. A simple apparatus was constructed to test the bending strength of the stems. After being cut to the required length, the stem was fastened at the base so as to hang horizontally and the natural bend read on a vertical scale. A ten grain weight was then added just at the base of the calyx and the scale again read, the difference between the two readings was taken as the basis for judging the relative stiffness of the stems.

The records are found in Table VIII. The results clearly indicate that the use of phosphoric acid gives the stiffest stems and that potash ranks next. Nitrogen in the form of dried blood gave very weak stems. The table shows, however, that there are factors other than the stiffness of the stem to consider in the successful growing of carnations. Plot 2 which received a complete fertilizer, gave a considerably larger number of flowers per plant, and longer stems than any of the other plots. The size of the flowers were as large as the average and larger than those on the phosphoric acid plot. It would seem, therefore, that for the best results it would be advisable to use a fertilizer containing a mixture of nitrogen, phosphoric acid, and potash with phosphoric acid in excess.

Table VIII. Shows Amount and Kind of Fertilizer Applied, the Size and Number of Carnation Blooms per Plant and the Length and Comparative Stiffness of Stems Averaged for the Seasons of 1904-5 and 1905-6.

Plot.	Fertilizer.		Blooms.			Comparative Stiffness.		
	Amount, pounds per acre.	Kind.	Number per plant.	Size.	Length of Stem.	Natural Bend.	Bend with added weight 10 grams.	Difference in bend.
1	8100	Dried sheep manure	15.3	2.6	16.8	66 37	127.16	60.79
2	1400	Dried blood.	....	......	....	....	....	....
....	300	Sulphate of potash.	....	......	....	....	....	....
....	2000	Dis. S. C. rock.	18.0	2.6	18.7	69.63	130.19	60.56
3	2000	Dis. S. C. rock.	14.3	2.55	17.0	56.03	101.44	45.41
4	......	Check.	14.4	2.6	17.5	62.57	117.26	54.69
5	300	Sulphate of potash.	15.0	2.6	17.9	65.67	117.15	51.48
6	1400	Dried blood.	16.5	2.6	18.5	78.39	150.89	72.50

DIFFERENT TIMES OF SETTING CARNATIONS.

A five years' test to determine the best time of planting carnations in the greenhouse, was concluded in the Spring of 1906. Cuttings for all plots were made on the same date. The plan followed was to grow the plants for plot No 1 in pots in the greenhouse while those for the other plots were planted in the field in April. Those in pots and one lot from the field were transplanted to the greenhouse benches about July 1. Plots 3 and 4 were transferred to the greenhouse from the field August 1 and September 1 respectively. The variety, William Scott, was used in the test the first year while Mrs. Thos. W. Lawson was used during the succeeding seasons. Only the number of blooms per plant was recorded during the first three years of the test, but in the later crops the size of the bloom and the length of the stem were measured. These data are given in Table IX.

The results indicate that the September planting gives a considerably larger number of blooms per plant, the number decreasing the earlier the planting was made. The largest blooms and the longest stems, however, seem to be produced on the early plantings.

Table IX. Shows for Five Seasons the Time of Planting from Pots or Field; the Number and Size of Blooms and Length of Stems Produced and the Average Results of all Plots.

SEASON.	PLOT 1. Planted July 1 from pots.			PLOT 2. Planted July 1 from field.			PLOT 3. Planted August 1 from field.			PLOT 4. Planted September 1 from field.		
	BLOOMS.			BLOOMS.			BLOOMS.			BLOOMS.		
	No.	Size, inches.	Length of stem inches.	No.	Size, inches.	Length of stem, inches.	No.	Size, inches.	Length of stem, inches.	No.	Size, inches.	Length of stem, inches.
1901-2...	9.1	......	......	11.6	.....	......	......	......	......	8.5	......	......
1902-3...	9.2	......	......	15.6	......	......	......	......	......	19.0	......	......
1903-4...	12.9	.....	......	12.2	......	......	16.8	......	......	23.1	......	......
1904-5...	7.5	2.7	18.5	7.5	2.7	18.8	14.5	2.6	19.2	18.3	2.5	18.4
1905-6...	5.6	2.7	17.8	9.5	2.6	18.9	10 2	2.7	17.8	17.2	2.6	15.7
Average.	8.86	2 7	18.1	11.2	2.65	18.85	13.8	2.65	18.5	17.2	2.55	17.05

CARNATIONS—CONTINUOUS CROPPING WITHOUT CHANGING SOIL.

The experiment in continuous cropping of carnations was similar to that already mentioned with chrysanthemums and lettuce. Instead of manuring and stirring six inches of the surface soil, the bed was double dug, that is, the spading was so done that 10 inches of the lower soil was brought to the surface and the upper 10 inches was placed below. This method has been continued for the past five years. One-half of the solid bed was treated in this way and the other half had new soil annually. The plants on the new soil generally yielded more flowers, and taking an average of the five years, gave two flowers per plant more than those on the continuously used soil.

All the plants made a satisfactory growth, however, and there were not more diseases on the plants in the old soil than there were in the new bed.

THE BURSTING OF CARNATIONS DUE TO LOCATION ON GREENHOUSE BENCHES.

It was noticed that the row of carnations located near the glass of the side benches produced more bursted flowers than did the other rows on the benches. During the winters of 1904-5 and 1905-6, a record was kept of the good flowers and the bursted flowers on the different rows. Table X shows that the row nearest the glass produced 21 per cent. of bursted flowers while only one other row gave as high as 7 per cent.

The reason usually assigned for this trouble, is that plants hardened off by being grown on soil kept rather dry or by having the growth checked in other ways, are likely to produce a larger percentage of bursted flowers when over stimulated by addition of rich food or of moisture. In this case it was found almost impossible to secure uniform conditions near the glass, the soil drying out badly although receiving a normal supply of water. Many growers find less trouble with this bursting of the calyx when the benches are so placed as to allow a walk between them and the side walls.

Table X. Shows Total Number of Good Blooms, and Total Number and Percentage of Bursted Blooms for the Seasons of 1904-5 and 1905-6.

Row.	BLOOMS.		
	Good.	Bursted.	
	Number.	Number.	Per cent.
1 near glass.	797	172	21
2	731	47	6
3	780	62	7
4	825	57	6

SUB-IRRIGATION VS. SURFACE WATERING FOR LETTUCE AND CARNATIONS.

Numerous reports of striking gains in yields and marked immunity from disease in supplying water to the roots of plants in underground irrigation systems, led to the following tests of the comparative value of sub-irrigation and surface watering. This test was started in the greenhouse during the season of 1899-1900, using lettuce as the crop.. Three beds were prepared with sub-irrigation systems with corresponding plots to be watered on the surface. The underground systems consisted primarily of a cement basin provided with overflow outlets at a height of three inches. Plot 1 had bricks with the lower edges chipped off, laid in the bottom of the cement basin to allow circulation of water. Plot 2 was provided with one line of two-inch tile, and plot 3 had two lines of two-inch tile.

Rich soil to the depth of six inches was placed in these plots and two crops of lettuce were harvested from all plots. Table XI gives the weights of lettuce produced on each plot and the total yields.

One crop of lettuce was grown on sub-irrigated and surface watered plots in 1905, with results similar to those given in the above table. The weights of lettuce produced on the two plots, were 67 ounces and 71 ounces respectively.

Table XI. Shows Weights of Two Crops of Lettuce Produced on Sub-Irrigated and Surface Watered Plots in Season of 1899-1900.

Crop.	PLOT 1.		PLOT 2.		PLOT 3.	
	Sub-irrigated, brick bottom.	Surface watered.	Sub-irrigated, one line of tile.	Surface watered.	Sub-irrigated, two lines of tile.	Surface watered.
	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.	Weight, ounces.
First	105	95	86	86	95	93
Second	98	110	92	100	105	112
Total..	203	205	178	186	200	205

A similar test using carnations as the crop was begun in the Fall of 1901 and continued for four years. The variety William Scott was used the first season and Mrs. Thos. W. Lawson in those following. No records were kept for the first two years except the number of blooms produced. During the last two years the size of the bloom and the length of stem were also recorded. These results are given in Table XII.

Table XII. Shows Number and Size of Blooms and Length of Stems of Carnations Produced on Sub-Irrigated and Surface Watered Plots for Four years.

YEAR.	PLOT 1—SUB-IRRIGATED.			PLOT 2—SURFACE WATERED.		
	BLOOMS.			BLOOMS.		
	Number per plant.	Average size inches.	Length of stem inches.	Number per plant.	Average Size inches.	Length of stem inches.
1901–2	9.3	....	....	8.6	....	....
1902–3	17.3	....	....	23.1	....	....
1903–4	25.1	2 6	18.5	19.7	2.6	17.2
1904–5	14.3	2.6	16.6	15 5	2 6	16.9
Average..........	16.5	2.6	17.5	16.7	2.6	17.5

The result of these experiments seem to indicate that sub-irrigation does not give enough better results to warrant the extra expense of construction. When carefully and thoroughly done, the surface watering gave very satisfactory results in yield and quality of product with no more trouble from disease than was true with plants sub-irrigated.

SOLID BEDS VS. BENCHES FOR TOMATOES, CARNATIONS AND LETTUCE.

The difference of opinion in connection with the growth of crops upon an ordinary solid bed or upon raised benches with heating pipes beneath, continues to be an interesting one with greenhouse men. Many establishments have both styles and get good results from each. Like many other problems relating to horticulture, conditions enter largely into the question of which some are,—the crops to be grown, value of lumber to renew benches, liability of the soil to become infested with disease spores and insects.

The items herein noted have been gathered from the work with various crops.

The solid bed, running through the center of the house, was 8 feet 6 inches wide and 2 feet deep. The benches were 2 feet and 6 inches above the floor with hot water pipes beneath. They were 3 feet and 8 inches wide, 6 inches deep, and were placed within 8 inches of the glass sash on the side walls.

Six inches of the surface soil of the solid bed was renewed each year. All of the soil on the benches was taken off and replaced by new soil annually.

With regard to diseases, it can not be said that there were any more on solid beds than on benches. Regarding insects, however, the nematode worm got into the solid bed planted in tomatoes and lived over from year to year usually interfering a good deal with the second crop.

Data on crops of tomatoes, carnations and lettuce are available for comparison of this work.

Tomatoes—The average of four crops per plant on benches was 10.4 fruits, weighing 2 lbs. 3 ozs. The average on solid beds was 13.1 fruits, weighing 2 lbs. 2 ozs. The fruits ripened on both beds at the same time and there was practically no real difference in results except that the fruits from the benches were slightly larger than the others and the plants on solid beds continued to produce fruit later in the spring than did those on benches. The solid bed was easier to water than the benches.

Carnations—The average results of two crops produced on benches and solid beds follow:

Benches—15.9 blooms, size 2.7 inches, length of stem 17.8 in.
Solid beds—17.4 blooms, size 2.5 inches, length of stem 17.0 in.

About the only difference apparent in the above table is the extra flowers per plant on the solid bed. This was probably due to the better growth in late Spring and the plants were always more robust on the solid beds.

Lettuce—The records show that while the midwinter crop was usually about equal on the solid bed and bench, the Spring crop was heavier on the solid beds.

VARIETY TEST OF TOMATOES IN THE GREENHOUSE.

In the Spring of 1899, several of the ordinary garden varieties of tomatoes were tried in the greenhouse to compare with the Lorillard, a variety quite generally used for forcing. The fruit was considerably affected by rot and only a few of the perfect fruits were weighed. The yields were calculated from the weight of an average sized fruit. The record of the results, which are approximate only, are given in Table XIII.

Table XIII. Shows Varieties of Tomatoes and Weight of Fruit per Plant in 1899 and 1900.

Variety.	Year, 1899 Weight of fruit per plant. oz.	Year, 1900. Weight of fruit per plant. oz.
Lorillard	60	46
Brinton	90	
Acme	84	50
World's Fair	100	
Bond Early	80	
Dwarf Aristocrat	60	8
Climax	60	25
Atlantic Prize	48	
Paragon	60	
Freedom		12
Ponderosa		37
Stone		50
Chemin		40
Beauty		50
Enormous		6
Early Bird		9
Buckeye State		36
Royal Red		27
New Queen		25
Matchless		56

A similar test with a larger list of varieties was concluded the following Winter. The fruit was weighed and the yields calculated per plant. The results indicate that those varieties commonly grown in the field succeed under glass equally as well as the Lorillard. It was found, however, that the fruit of these varieties did not find nearly so ready a sale during the winter as that of the Lorillard because of their larger size, the winter demand being for medium sized fruits.

A second crop was left to pollinate itself naturally, but no records were kept. A few varieties such as Dwarf Aristocrat had an average set of fruit, but in general practice it has been found necessary to pollinate most varieties artificially as the set of fruit depends almost entirely upon this hand pollination.

DISTANCE APART TO PLANT TOMATOES IN GREENHOUSES.

In the Fall of 1901 an experiment was started to test the planting of tomatoes in the greenhouse at different distances apart. The plants were pruned and trained to a single stem. The variety, Sutton's Best of All, was used the first year and Lorillard in the three years following. In plot 1 for the first crop the plants were set 1x1 feet and in plot 2, 1x2 feet. The first yielded 690 ruits weighing 122 pounds while the latter yielded only 450 fruits weighing 105 pounds. In this case the closer planting seemed to give the best results except that the fruit did not color up as well as did that on plot 2. To overcome this difficulty the second crop on plot 1 was planted ½x2 feet apart thus occupying the same amount of space, but at the same time allowing a greater amount of sunshine between the rows. The results of this crop show that the closer planting still gave more fruit per 100 square feet of space, but did not weigh as much by one pound as did the wider planting. The color of the fruit in plot 1 was better than in the first crop, but still not as good as that from plot 2. On account of this lack of color it was thought best to increase the distance between the plants so that for both crops of the season of 1902-3, plot 1 was planted 1x2 feet and plot 2, 2x2 feet. The yield found in Table XIV show results in favor of the closer planting.

Table XIV. Shows Distance Between Tomato Plants, Number of Crops. Number and Weight of Fruits per Plant and the Number and Weight of Fruits per 100 Square Feet of Space.

Year.	Crop.	Distance between plants, feet.	Average number of fruits per plant.	Average weght of fruit per plant ounces.	Number of fruit per 100 square feet of space.	Weight of fruit per 100 square feet of space, pounds.
1901-2	First	1x1	6.9	19 2	690	120.0
"	"	1x2	9.0	33.6	450	105.0
"	Second	1x2	8 9	19.1	445	59.6
"	"	½x2	4.9	9.4	490	58.7
1002-3	First	1x2	8.7	29.2	435	91.2
"	"	2x2	12.4	49.1	310	76.7
"	Second	1x2	9.9	24.5	495	76.5
"	"	2x2	16.0	49 2	400	76.8
1903-4	First	2x2	15.7	49.0	392	76.5
"	"	2x2½	16 4	57.2	326	71.5
"	Second	2x2	12.0	32.2	300	50.3
"	"	2x2½	11.7	40.0	234	50.0
1904-5	First	2x2	19.8	86.1	495	134.5
"	"	2x2½	15.5	68.2	310	85.2

Three crops, two in the season of 1903-4 and one in 1905, were raised, in which plot 1 was planted 2x2 feet and plot 2, 2x2½ feet. The results indicate that the latter distance is too far apart for the most profitable returns. It is, however, difficult to draw any definite conclusions from the data available because all the different distances apart were not tested during the same seasons and under the same conditions.

The records of these tests are found in Table XIV, which gives the distance apart, the number of crops raised, the number and weight of fruit produced per plant and the number and weight of fruit produced per 100 square feet of space.

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THE EFFECT OF ANIMAL DIGESTION AND FERMENTATION OF MANURES ON THE VITALITY OF SEEDS.*

By Edward Ingram Oswald.

The investigations reported upon in this bulletin were done under the direction of the Experiment Station and all of the material, apparatus, &c., used was supplied by them. The work as planned and carried out at first was limited to a study of the effect of the fermentation of manure upon the vitality of weed seeds and was taken up at the suggestion of Prof. W. N. Hutt, then horticulturist of this Station. After this part of the work was completed the Director of the Station suggested the broadening of the work so as to include a study of the effect of the passage of seeds through the digestive system of animals upon their vitality.

These investigations were undertaken so as to give some detailed knowledge on these points and enable farmers to know something more definite as to the risks involved in introducing new weeds through the purchase of manure, hay and other feed stuffs. It was also hoped that some data would be procured which would enable farmers to follow such plans as would reduce the liability of introducing new seeds to a minimum.

In former years the catalog of Maryland weeds did not include the large number of species that it does today. It is quite evident from this fact that new ones have been brought hither through agencies favorable to their distribution.

Some of these may have been carried by floods, winds or birds; but probably the most common medium for transporting injurious seeds into a community is through the carloads of manure shipped from cities and also through the loads of hay, straw and grain that are procured from distant markets.

*This piece of work was done under the direction of the Experiment Station and the matter was submitted as a thesis for the B. S. degree in horticulture June, 1908, Maryland Agricultural College.

Weed seeds may find their way into manure from two different sources; first by passing through the body of the consuming animal, and second by falling from the feeding racks or from among the bedding. In the first part of this particular investigation the latter method was followed out as the most plausible source of these injurious seeds.

The economic importance of this subject was first brought to prominent notice through the frequent inquiry of the truck gardeners as to the likelihood of introducing new weeds by means of the manure that they purchase from the city.

A second inquiry comes from the general farmer, who also asked if it was a dangerous practice to throw all the filth that accumulates on the farm upon the barnyard, pound or manure pile instead of burning it, and whether such a practice is likely to scatter the weeds over all parts of the farm?

A third inquiry is made by the dairymen, who questioned whether it is possible to introduce noxious weeds upon the dairy farm by buying hay, grain and mixed feeds.

In order to be able to answer these inquiries, it is necessary to investigate the effects of manure upon the germination of weed seeds under all the conditions met with in practice. These investigations were planned and conducted so as to fulfill as nearly as possible the conditions of the average farmer.

APPARATUS AND SEEDS USED.

In this test fifty-two varieties of the most malignant weed seeds found in Maryland were used.

The experiment required the following articles: A germination box, three yards of No. 20 mesh brass wire gauze, an apparatus for sterilizing soil, six Farenheit thermometers and twelve two horse wagon loads of manure, six of cow and six of horse manure.

The seeds used were secured from two separate sources. As many as possible were obtained from different localities within the State, the remainder were procured through the assistance of the United States Department of Agriculture, Bureau of Plant Industry.

The selection of the varieties used in the test was governed by making a careful examination of the Botanical Survey of Maryland and selecting therefrom the varieties known as the most noxious.

A list of seeds used will be found in Table I, together with the results of a germination test of the same.

Each variety of weed seeds to be used in the test was kept in a separate envelope, which was numbered. There were fifty-two different weeds represented in the test. In order to save time and avoid sterilizing more soil than was absolutely necessary the seeds were tested for germination, not in soil, but in a saw dust germination box, the same as used in the ordinary germination test for seed corn. The germination box was placed in a greenhouse, where it was exposed to ideal conditions for germination, and left there until the fifth day,

when it was examined and notes taken. The box was examined in a similar manner every fifth day for twenty days.

The following table gives the results obtained from the germination test as observed at the four openings of the box; also the total percentage of germination, with appropriate explanation when it is found necessary.

Table I. Showing Germination Test to Ascertain Percentage of Vitality.

No.	Botanical Name.	Common Name.	No. seeds tested.	No seeds germ.	Percentage germ.
1	Comium maculatum, L.	Poison Hemlock	10	0	0
2	Ambrosia artemisiaefolia L.	Wild Tansy	10	6	50
3	Chemopodium album, L.	Lambs Quarters	10	7	70
4	Plantago lancealata, L.	Rib Grass	10	3	30*
5	Rumex Acetosilla, L.	Sheep Sorrel	10	5	50
6	Achillea Millefolium, L.	Yarrow	10	3	30
7	Ipomoea Jocq. hederacea, L.	Morning Glory	10	4	40
8	Daucus carota, L.	Wild Carrot	10	4	40
9	Solanum carolineuse, L.	Horsenettle	10	5	50x
10	Verbena pastada, L.	Blue Vervain	10	0	0

TABLE I—*Continued.*

No.	Botanical Name.	Common Name.	No. seeds tested.	No. seeds germ.	Percent-age germ.
11	Solanum nigrum, L.	Common Nightshade	10	4	40
12	Echium vulgre, L.	Blueweed	10		
13	Cuscuta arvensis, Beyrich	Field Dodder	10	7	70‡
14	Amaranthus panisulatus, L.	Pigweed	10		
15	Solidago canadensis, L.	Canada Goldenrod	10	7	70‡
16	Plantago mojor, L.	Common Plantain	10	2	20x
17	Phytolacca decandra, L.	Common Poke	10	4	40
18	Malva rotundifolia, L.	Running Mallow	10	3	30
19	Amaranthus retroflexus, L.	Rough Pigweed	10	2	20x
20	Ambrosia trifida, L.	Large Rag weed	10	0	0
21	Carduus arvensis, L.	Canada thistle	10	0	0
22	Chaetochloa glauca, L.	Pigeon Grass	10	6	60‡
23	Medicago lupulina, L.	Black Medic	10	5	50

TABLE I—*Continued.*

No.	Botanical Name.	Common Name.	No. seeds tested.	No. seeds germ.	Percentage germ.
24	Verbascum blattaris, L.	Moth Mullen	10	3	30‡
25	Poa pratensis, L.	Kentucky Blue Grass	10	4	40
26	Bursa bursapastosis, L.	Shepherd's Purse	10	0	0*
27	Polygonum pennsylvanicum, L.	Persicaria	10	0	0*
28	Datura tatula, L.	Purple Thornapple	10	2	20x
29	Bromus secalinus, L.	Cheat	10	6	60
30	Cichorium Intybus, L.	Chicory	10	3	30
31	Cuscuta Epithymum, Murr.	Clover Dodder	10	7	70
32	Lepidium Virginicum, L.	Wild Pepper Grass	10	6	60*
33	Polygonum persicaris, L.	Lady's Thum	10	3	30
34	Onagra biennis, L.	Evening Primrose	10	7	70
35	Syntherisma fimbriata, Nash.	Common Crab grass	10	8	80x
36	Rumex obtusifolius, L.	Bitter Dock	10	10	100x

TABLE I—*Continued.*

No.	Botanical Name.	Common Name.	No. seeds tested.	No. seeds germ.	Percentage germ.
37	Allium cernuum, Roth.	Wild Onion	10	0	0
38	Pastinaca sativa, L.	Wild Parsnip	10	1	10
39	Alsina Media, L.	Common Chickweed	10	4	40
40	Agrostemma githago, L.	Corn Rose	10	9	90‡
41	Malva rotundifolia L.	Common Mallow	10	2	20
42	Prunella vulgaris, L.	Self-heal	10	0	0*
43	Rudbeckia hirta, L.	Black eyed Susans	10	3	30x
44	Melilotus alba, Devs.	White Sweet Clover	10	8	80
45	Bidens frondosa, L.	Black Beggar ticks	10	0	0
46	Anthemis cotula, L.	Mayweed	10	4	40‡
47	Thlaspi arvense, L.	Field Penny-cress	10	3	30
48	Agropyron spicatum, L.	Quack Grass	10	7	70

* Secreted a jelly during germination.
‡ Quick to germinate.
x Slow to germinate.

TABLE I—*Continued.*

No.	Botanical Name.	Common Name.	No. seeds tested.	No. seeds germ.	Percentage germ.
49	Lactuca scariola, L.	Prickly Lettuce	10	2	20
50	Sisymbrium allissimum, L.	Mustard	10	4	40
51	Avena fatua, L.	Wild Oats	10	8	80
52	Helianthus annuus, L.	Sunflower	10	6	60

It will be observed in the above table that the time required in germination varies with different varieties. A number of them failed to germinate at all, but were not, however, rejected. They were retained in the experiment with the expectation that possibly after they had undergone the action of salts present in manures, they might possibly be induced to germinate.

The failure of some of the varieties may be attributed to various causes. The seeds may have been dead, the conditions may not have been favorable for their germination or the proper age for germination had not been reached. The latter is probably the most plausible as indicated by the work of Dr. W. J. Beal, Professor of Botany at the Michigan Agricultural College, in his experiment with the vitality of weed seed after being buried in the soil for different lengths of time.

Dr. Beal found that instead of a gradual decrease in the numbers of varieties that germinated as the time increased, that at the end of 25 years, one more variety germinated than at the end of 5 years.

Some of the varieties used in his work were the same as those which failed to germinate in the foregoing test. Therefore, we have reason to conclude that it is the habit of some weed seeds to remain in a dormant state for many years before germination.

It will also be noticed that the percentage of germination varies in the different varities notwithstanding the fact that the conditions of each were the same and that all of the seeds were gathered the previous fall. Dr. Beal also noticed this in his experiments, that some seeds secreted a transparent jelly-like substance which envelops the specimen, giving it somewhat the appearance of a frog's egg. This occurs only with seeds that have a hard, smooth coating.

THE EFFECT OF FERMENTING MANURE UPON THE VITALITY OF WEED SEEDS.

Three kinds of stable manure were used, namely: Horse manure, cow manure and horse and cow manure mixed in equal parts. In the meantime six bags were made from brass gauze, holding about one gallon each. These were sewed together with copper wire.

From each of the three kinds of manure samples were taken and thoroughly sterilized by boiling for at least one hour. This treatment destroyed practically all foreign seeds and fungus spores that the manure might contain. From each vessel containing the sterilized manures a sufficient quantity was drawn to fill two of the gauze bags about three-quarters full. This was in turn divided into two equal parts. Into one of these parts was put 100 seeds of each of the 52 varieties to be tested. Into the other a promiscuous number of each of the same varieties of seeds. After they were thoroughly mixed with the samples of manure, the seeds were placed into the gauze bags, the latter being sewed shut with wire. These bags were numbered A and B with lead tags, the numbers of which were stamped into the lead. No. A contained the counted seeds, and was used in the test, while No. B contained the uncounted seeds was used as a check.

The process was repeated with the sterilized samples from each kind of manure. In addition to A and B all the bags filled with the horse manure were numbered 1; those filled with cow manure No. 2, and those filled with the mixed manures No. 3. By this method of identification the pile to which the bag belonged was indicated.

The same day the manure was hauled and placed into three separate piles about 4 feet square and 4 feet high, containing about two or three tons each. The manure was tramped so as to make firm piles. The gauze bags containing the seeds were placed one foot apart about the center of their respective piles and the manure closely packed around them.

A thermometer was placed in each pile of manure so that the bulbs were between the gauze bags containing the seed and on a level with them. The readings of the thermometers were made morning and evening for 60 days. The results are compiled and shown in the following table:

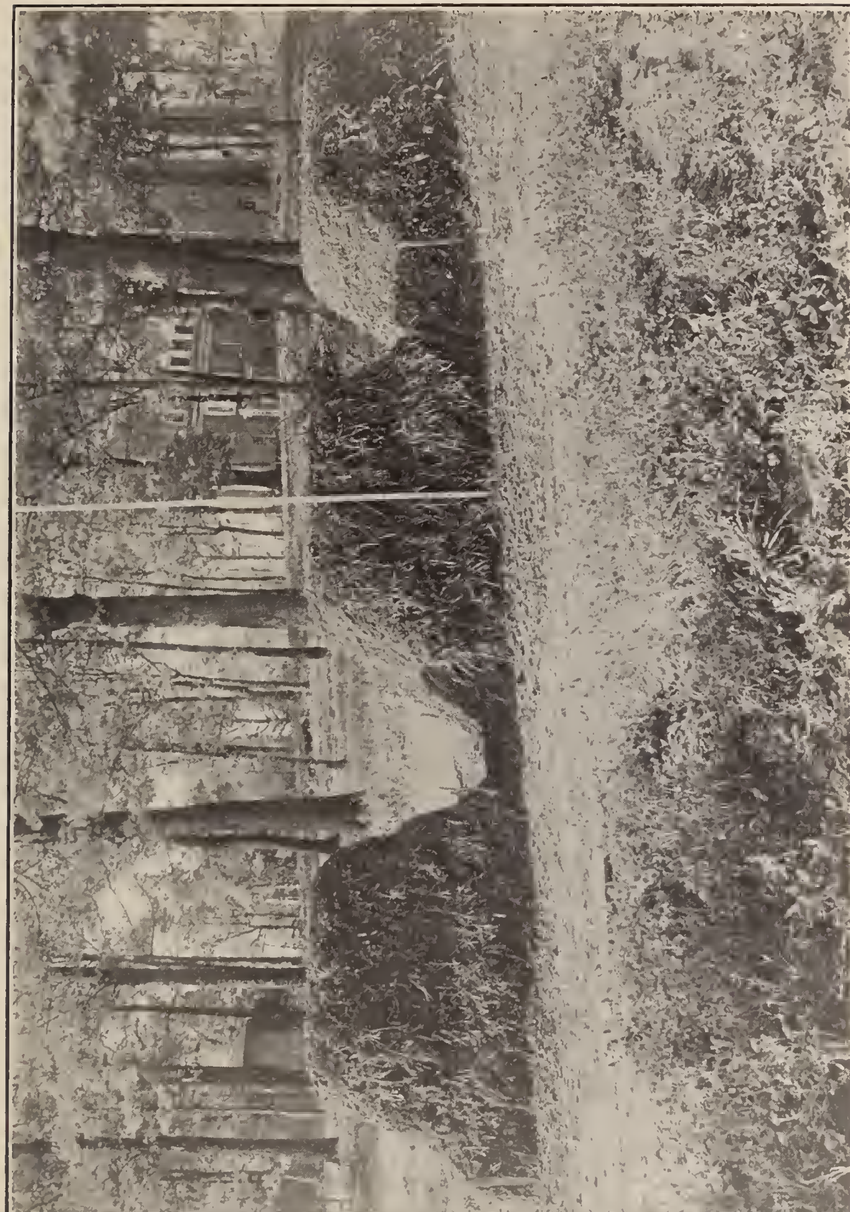

Figure 1.—The piles of manure after seeds were placed in them.

Table II. Showing the Temperatures Which Were Taken Morning and Evening from Thermometers Inserted in the Piles of Manure.

KINDS OF MANURE.	Highest temperature F.	Lowest temperature F.	Mean temperature F.
Horse manure...............	201°	40°	134°
Cow manure..................	168°	40°	120°
Horse and cow manure mixed.	188°	40°	122°
Outside the manure..........	....	....	60°

At the end of 60 days the temperature within the manure had fallen until it was about the same as that outside, and for this reason was discontinued, knowing that all of the heat had passed off.

In order to imitate as nearly as possible the conditions found in the barnyard of the average general farmers where the manure is hauled out but twice a year the seeds were allowed to remain in the piles for 6 months.

The method adopted in testing the vitality of the seeds after they had passed through the fermentation in the piles of manure was as follows: First, in order to secure accurate results, it was essential that the seeds be planted in soil that was free from weed seeds. This was procured by sterilizing the soil. That used was a good grade of potting soil sterilized by two different methods. First, by live steam, in which the soil was placed in a barrel through which a steam pipe was inserted and the steam allowed to escape at the bottom of the barrel. The soil was mixed with water until about the consistency of mortar. The steam was then turned in and the mass allowed to boil for more than two hours. The other method employed was dry sterilization, in which the soil is baked in the oven of a kitchen range in pans for 3 hours.

In a preliminary test of the two methods it was found that sterilization in the former case was insufficient, owing to the fact that a number of varieities of weed seeds found in the soil still continued to grow after the soil had been boiled. The soil sterilized by the dry method was found to be free from seeds having any vitality whatever.

The bench of the greenhouse was next divided into 6 equal parts; each part being about 12 inches by 36 inches. These sections were filled with soil sterilized by the dry method to a depth of one inch and numbered corresponding to the numbers on the gauze bags which contained the seeds.

The gauze bags were opened and the contents taken from each one and scattered evenly over the corresponding part of the bench. Over this a thin layer of sterile soil was sprinkled, just enough to cover the seeds and prevent their being exposed.

These plots were kept watered and given careful attention. After a reasonable length of time they were examined and without a single exception all of the seeds failed to germinate. The seeds that could be found were easily crushed between the fingers, thus showing that they had rotted and their vitality was destroyed.

EFFECT OF PARTIALLY FERMENTED MANURE ON THE VITALITY OF WEED SEEDS.

The work so far gives results based on the general farmer's method of caring for manure. In order to cover the conditions usually followed by dairymen and gardeners, where the manure remains in piles only for a short time, another set of experiments were started the same fall. These were conducted in exactly the same manner as was the former test, excepting that the seeds were allowed to remain in the pile a shorter time. The second lot remained in the manure for only one month, after which they were taken from the piles and placed over sterilized soil on the greenhouse bench exactly the same as the seeds were in the former experiments, and they received the same attention.

After a reasonable length of time the plots were examined and the results found were synonomous with those of the plots in the previous experiment, except that some of the seeds found were still firm and would not crush when pressed between the fingers. They were the following varieties:

Plantago lancealata, L.
Rib Grass.

Slanum carolineuse, L.
Horsenettle.

Plantago major, L.
Common Plantain.

Ambrosia trifida, L.
Large Ragweed.

Rumex obtusifolius, L.
Bitter Dock.

Malva rotundifolia, L.
Mallow.

THE EFFECT OF PASSING GRAIN AND WEED SEED THROUGH THE DIGESTIVE CHANNEL OF DOMESTIC ANIMALS UPON THEIR VITALITY.

So far we have dealt with the effect of manure upon the vitality of weed seeds as influencing their distribution. From the table of results in the first part we find that no seeds whatever grew after they were taken from the manure piles, this leading us to conclude that the heat and chemical action which took place under fermentation had a devitalizing effect on weed seeds, and that little danger of bringing

noxious weeds from one locality to another would be incurred by the use of manure that had remained in piles for one month or more.

To answer questions from those who do not allow the manure to rot in piles but haul it directly from the stable to the field, or those who allow their farm animals to graze in the fields and the droppings to remain wherever they chance to fall, it is necessary to deal with the effects of digestive fluids upon the vitality of seeds. Accordingly the following experiments were conducted. They were arranged so as to meet every possible condition.

The importance of this phase of the work was especially emphasized by the inquiries of the consumers of Sucrene and molasses feeds as well as the manufacturers of the same, whose desire it was to learn whether it was possible to introduce seeds through the use of these feeds. Their inquiry was probably based on statements made by the Vermont Agricultural Experiment Station in their bulletin No. 131 on "Commercial Feeding Stuffs." As a result of the investigation described in this bulletin it was found that many of the commercial feed stuffs contained a large number of noxious weed seeds. Some brands of molasses feeds sold as dairy feed were reported to contain as many as 129,000,000 weed seeds to a ton.

Even though these feeds contain large numbers of weed seeds we would not be justified in concluding that all of them will pass through the animal and still retain their average degree of vitality, as they are in a large measure liable to injury by being crushed between the teeth of the feeding stock and by the action of the digestive juices.

The first step taken in this experiment was to procure a number of the worst and most common weed seeds in Maryland and those most often found in hays and commercial feeds. A number of common grains and grasses were also used.

A sample of 50 seeds was taken from every variety of seeds to be used in this experiment, and these 50 seeds were tested for their vitality so as to ascertain the percentage of germination of each variety. The germination test was conducted exactly in the same manner as it was with the seeds used in the test under fermenting manure conditions.

For the sake of convenience these seeds were divided into three lots and numbered 1, 2, 3, respectively, as seen by the tables. The result of the germination test was kept in tabulated form, as will be seen from the appended tables Nos. 3, 4, 5.

Table III. Showing Result of Germination Test of Lot No. 1.

No.	Botanical name.	Common name.	No. seeds tested.	No. seeds germi.	Percentage germi.	Remarks.
1	Agrostis alba, L.	Red top	50	40	80	
2	Avena sativa	Oats	50	40	80	
3	Hordeum vulgare	Barley	50	50	100	All strong.
4	Poe pratensis, L.	Blue grass	50	15	30	Poor germination.
5	Secale calecer, L.	Rye	50	30	60	2 strong, 4 weak.
6	Symtherisma fimbriata, Nash.	Crab grass	50	40	80	
7	Trifolium incarnatum L.	Crimson clover	50	35	70	
8	Trifolium pratense, L.	Red Clover	50	30	60	
9	Trifolium repens, L.	White clover	50	45	90	
10	Triticum, vulgare	Wheat	50	50	100	All strong.
11	Vicia hirsuta, L.	Hairy vetch	50	25	50	2 strong, 3 weak.
12	Zea Maize	Corn	50	50	100	All strong.
	Total........................		600	450	75	

Table IV. Showing Result of Germination Test of Lot No. 2.

No.	Botanical Name.	Common Name.	No. of seeds tested.	Total Number grew.	Percentage grew.	REMARKS.
1	Agrostemma Githago, L.	Cockle	50	30	60	
2	Ambrosia artemsiaefolia, L.	Rag Weed	50	2	4	Weak germination.
3	Bidens bipemata, L.	Spanish needles	50	00	00	No germination.
4	Datura Stramonium, L.	Jamestown weed	50	20	40	Quick to Germinate.
5	Ipomoea hederacea, Jocq.	Morning glory	50	10	20	
6	Lepidium campestre, L.	Pepper weed	50	25	50	Slow to germinate.
7	Malva rotunbofolia, L.	Mallow or velvet leaf	50	15	30	Quick to germinate.
8	Polygonum Hydropiper, L.	Smart Weed	50	4	8	
9	Rumex altissimus, Wood	Narrow Dock	50	10	20	
10	Sisymbrium allissinum, L.	Wild mustard	50	20	40	
11	Solanum carolineus, L.	Horse nettle	50	15	30	Slow to germinate.
	Total................................		559	151	27.4	

Table V. Showing Result of Germination Test of Lot No. 3.

No.	Botanical Name.	Common Name.	No. of seeds tested.	No, seeds grew.	Per-centage grew.	REMARKS.
1	Agrostemma Githago, L.	Corn Rose	50	45	90	Quick to germinate.
2	Alsine media, L.	Common Chickweed	50	15	30	
3	Amaranthus retroflexus, L.	Rough Pigweed	50	10	20	Slow to germinate.
4	Avena fatua, L.	Wild Oats	50	40	80	
5	Bromus secalinus, L.	Cheat	50	25	50	
6	Chaetocheoa glauca, L.	Pigeon Grass	50	30	60	Quick to germinate.
7	Cuscuta Byrich arvensis,	Field Dodder	50	35	70	
8	Cuscuta Epithymum, Murr.	Clover Dodder	50	35	70	
9	Datura tatula, L.	Purple Thorn Apple	50	10	20	Slow to germinate.
10	Medicago lupulina, L.	Black Medick	50	25	50	
11	Melilotus alba, Devs.	White Clover	50	40	80	
12	Plantago lancealata, L.	Rib Grass	50	15	30	Jelly secreted before germination starts
13	Rudbeckia hirta, L.	Black-eyed Susan	50	10	20	Slow to germinate.

TABLE V.—*Continued.*

No.	Botanical Name.	Common Name.	No. of seeds tested.	No. seeds grew.	Percentage grew.	REMARKS.
14	Rumex obtusifolius, L.	Bitter Dock	50	50	100	Slow to germinate.
15	Solanum nigrum, L.	Common Nightshade	50	20	40	
	Total............	....	750	405	54	

To facilitate the keeping of an accurate record 2000 seeds were counted from each variety, this being considered large enough number to give an accurate result.

METHODS USED IN FEEDING OF THE SEEDS.

The animals chosen in this work were three healthy yearling calves, yearlings being chosen because their digestive organs were about of an average strength as based on the young calf and the old mature animal. These three calves were numbered 1, 2, 3, to correspond with the numbers given to the groups into which the seeds divided. They were placed in separate stalls with cement floors, so that the manure from each one could be kept separate.

A balanced ration of wheat bran, gluten meal, malt sprouts and cut corn fodder was prepared and fed twice a day, morning and evening. The object in using the above ration was to be free from having any weed seeds in the feed other than those fed in the experiment and of which a record was kept. To be sure the digestive tract of the animals was free from weed seeds, the calves were fed a preliminary feed of the balanced ration four days before the test began.

On the fifth day a portion of each group of seeds was mixed with the ration and fed to the calf correspondingly numbered. The seeds were fed for four days, the total number being distributed equally between each feed. After the second day, or after the fourth feed, the manure from each calf was saved separately for five days, which ran it three days longer than the feeding of the seeds was continued. This was done to be sure that every seed would have time to pass through the animal's body. No bedding was used under the calves in order to prevent the introduction of any foreign weed through the bedding and at the same time to keep the bulk of manure small.

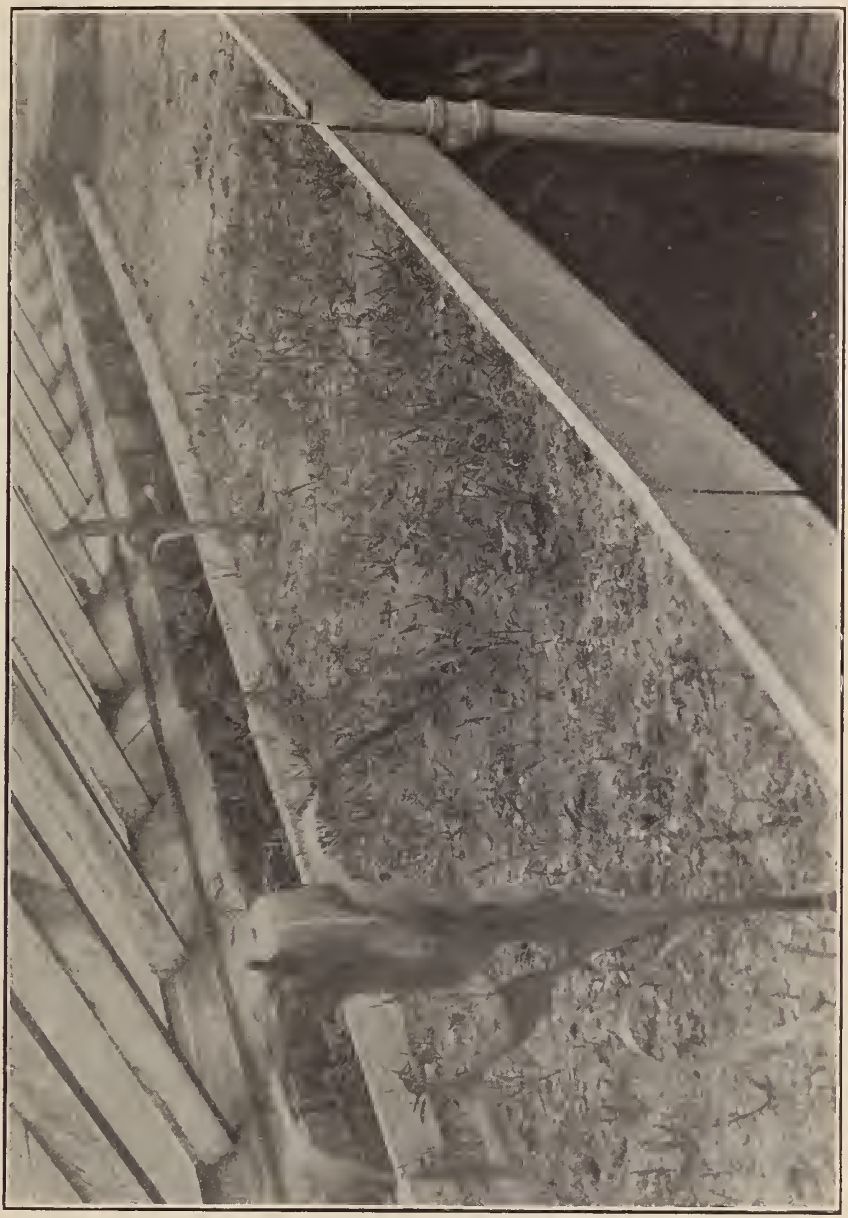

Figure 2.—Plot 1 A., showing the growth of some grain seeds one month after planting.

CONDITIONS SIMILAR TO THE PRACTICE OF TOP DRESSING WITH FRESH MANURE.

Each day as the manure was separately and carefully collected into tubs numbered 1A and 2A it was washed through a series of sieves which allowed the soluble parts to pass out and retained the crude fiber and seeds on the sieves. This material was then spread ½ inch thick on the greenhouse bench over about one inch of sterile soil, sterilized by the baking process to make sure that all the seeds were killed. The benches were numbered 1A to 2A. Over this manure a thin layer of sterilized soil was spread to prevent the seeds from undue exposure.

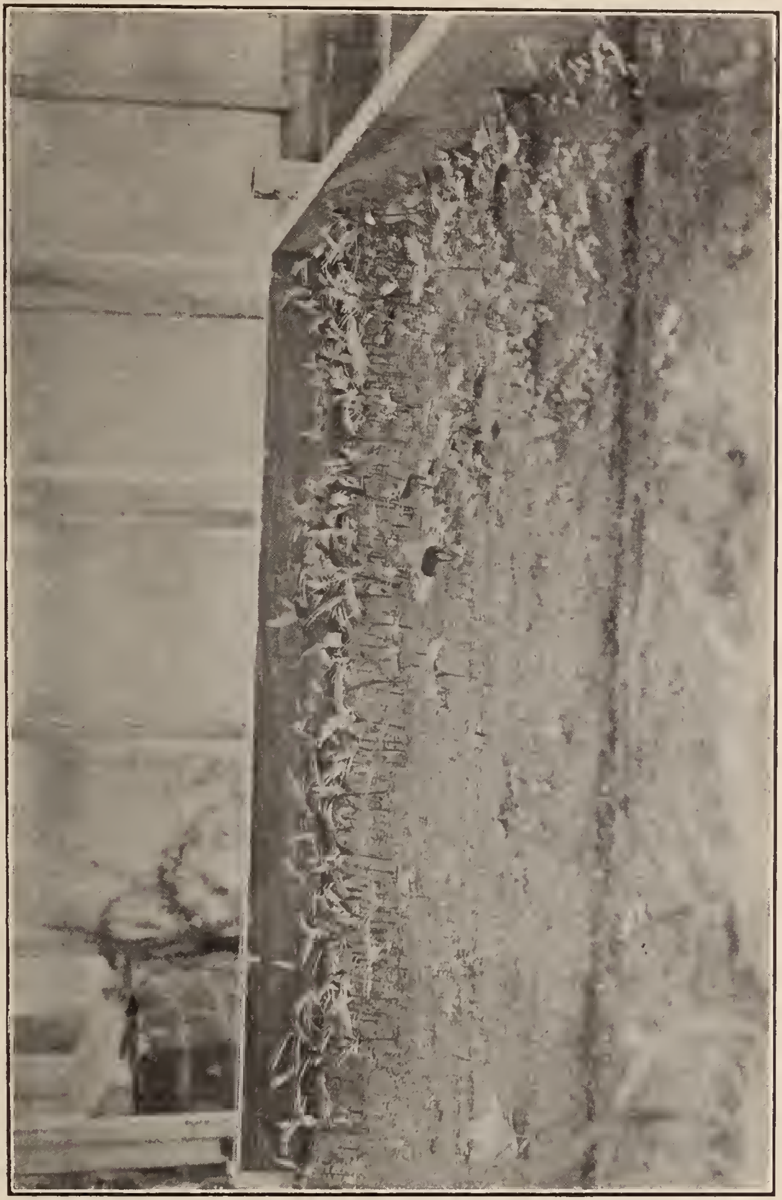

Figure 3.—Plot 2 A., showing the growth of some weed seeds fed in feed one month after planting.

Table VI. Showing Result After the Seeds Have Been Fed to Animals and the Manure Spread Over Sterile Soil. No. 1A. Manure Was Washed Through Sieves to Take Out Soluble Parts.

No.	Botanical Name.	Common Name.	No. of seeds fed.	No. that grew.	Percentage germi.	Remarks.
1	Tricicum vulgare	Wheat	2000	174	8.7	
2	Syntherisma fimbriata, Nash.	Crab grass	800	319	37	Vitality excellent.
3	Scale cereale, L.	Rye	1200	30	2 5	
4	Zea Maize	Corn	2000	4	02	Germination retarded.
5	Hordeum vulgare	Barley	2000	20	1	Weak germination.
6	Avena sativa	Oats	1600	4	25	Weak germination.
7	Agrostis alba, L.	Red top	1600	320	20	
8	Poa pratensis, L.	Blue grass	600	80	13	
9	Vicia hirsuta, L.	Hairy vetch	1000	110	24 6	Germination retarded.
10	Trifolium pratense, L.	Red clover	1200	36	3	Weak germination.
11	Trifolium repense, L.	White clover	1800	18	1	
	Total....		15800	1115	7.05	

Table VII. Showing the Result After the Seeds Were Fed to Animals and the Manure Spread Over Sterile Soil. No. 2A. Manure Was Washed Through Sieves to Take Out Soluble Parts.

No.	Botanical Name	Common Name.	No. of seeds fed	No. that grew	Percent grew	Remarks.
1	Malva rotundifolia, L.	Mallow Velvet leaf	600	60	10	Quick to germinate
2	Datura Stramonium, L.	Jamestown Weed	800	572	71.5	Quick to germinate
3	Ambrosia, artemsiaefolia, L.	Ragweed	80	52	65	
4	Rumex altissimus, wood.	Narrow Dock	400	60	15	
5	Agrostemma Githago, L.	Cockle	1200	10	8	
6	Sisymbrium allessirnum, L.	Wild Mustard	800	80	10	
7	Lepidium compestre, L.	Pepperweed	1000	10	1	Slow to germinate
8	Polyganum Hydropiper, L.	Smart weed	320	32	10	
9	Impoea hederacea, Jocq.	Morning Glory	400	4	1	
10	Solanum carolineus, L.	Horsenettle	600	740	123	Slow to germinate
11	Bidens bipennata, L.	Spanish needles	....	....	....	
	Total	....	6200	1620	26.1	
	Totals (tables 6 and 7)........		22000	2735	12.8	

CONDITIONS SIMILAR TO THE PLOWING UNDER OF FRESH MANURE.

The manure from calf No. 3 was not passed through sieves but put directly in a similarly prepared bench in the greenhouse and covered to a depth of ½ inch and thoroughly mixed with the sterile soil contained on the bench. In practice of plowing the manure under of course it would be covered to a greater depth, but, all things considered, it was thought best to limit the depth in this test.

Each day as the manure was collected it was placed and treated as described. At the end of the fifth day the calves were free from the experiment and the manure saving was discontinued.

Table VIII. Showing Result After Seeds Were Fed to Animals and the Manure Spread ½ inch Thick Over Sterile Soil. No. 3A.

Manure Mixed With Sterile Soil.

No.	Botanical Name	Common Name	No. of seeds fed.	No. seeds grew.	Percentage grew.	REMARKS.
1	Rumex obtusifolius, L.	Bitter Dock	1000	26	2.6	Majority weak.
2	Plantago lancalata, L.	Rib Grass	300	25	8.3	Wilted away.
3	Amaranthus retroflexus, L.	Rough Pigweed	200	12	6	
4	Chaetocheoa glauca, L.	Pigeon Grass	600	50	8.3	Some wilted.
5	Alsine media, L.	Common Chickweed	300	11	3.6	
6	Agrostemma Githago, L.	Corn Rose	900	38	4.2	
7	Medicago lupulina, L.	Black Medick	500	5	1	
8	Cuscuta arvensis, Byrich	Field Dodder	700	18	2.5	

TABLE VIII.—*Continued.*

No.	Botanical Name	Common Name	No. seeds fed.	No. seeds grew.	Per-centage grew.	REMARKS.
9	Melilotus alba, Devs,	White Sweet Clover	800	6	.75	
10	Cuscuta epithymum, Murr.	Clover Dodder	700	7	....	
11	Avena fatua, L.	Wild Oats	800	....	....	
12	Rudbeckia hirta, L.	Black-eyed Susan	200	....	....	
13	Bromus recalinus, L.	Cheat	500	....	....	
14	Datura tatula, L.	Purple Thorn Apple	200	....	....	
15	Solanum nigrum, L.	Common Nightshade	400	....	....	
	Total............	....	8100	198	2.3	

CONDITIONS SIMILAR TO PASTURING CATTLE ON FIELDS.

So far the work done had only taken up conditions suited to the hauling of the manure direct upon the field. Numbers 1A and 2A were given about the same conditions as the manure that is placed on the field as a top dressing and exposed to rains which washes out the soluble parts to a greater or less degree. Number 3A fulfills as nearly as possible the conditions where the manure is harrowed directly into the soil or plowed under.

To bring about the conditions when the cattle graze on the fields two of the three calves used at first were placed under the same environments as before, and fed exactly the same preliminary ration. This time they were numbered 1B and 2B, and were fed the same quantity and kind of seeds and cared for in the same manner as before.

Instead of washing the manure through sieves, as in the experiment with 1A and 2A, it was placed directly over the sterile soil in the greenhouse bench to a depth of ½ inch. It was not mixed with the soil at all this time, nor was it even covered with a thin layer of soil. The object of this omission was to bring about conditions analagous to those where the manure is dropped unadulterated in the pasture fields.

Table IX. Showing the Result After Seeds Were Fed to Animals and the Manure Spread ½ inch Thick Over Sterile Soil. No 1B.

No.	Botanical Name.	Common Name	No. seeds fed	No. that grew.	Percentage germi.	Remarks.
1	Syntherisma fimbriata, Nash	Crab grass	800	160	20	Vilality good.
2	Triticum vulgare	Wheat	2000	12	.6	Some wilted.
3	Secale cereale, L.	Rye	1200	12	.6	Wilted away.
4	Zea Maize	Corn	2000	1	.05	Wilted away.
5	Vicia hirsuta, L.	Hairy Vetch	1000	20	2	Some wilted.
6	Agrostemma alba, L.	Red top	1600	17	1.06	
7	Poa pratensis, L.	Blue Grass	600	6	1	
8	Hordeum vulgare	Barley	2000			
9	Avena satilva	Oats	1600			
10	Trifolium repens, L.	White Clover	1800			
11	Trifolium pratensis, L.	Red Clover	1200			
12	Trifolium Incarnatum, L.	Crimson Clover	1400			
	Total..........	....	17200	228	1.33	

Table X. Showing Result After Seeds Were Fed to Animals and the Manure Spread 1-2 Inch Thick Over Sterile Soils, No. 2 B.

No.	Botanical Name	Common Name	No. of seeds fed	No. that grew	Per-centage grew	Remarks.
1	Malva rotundifolia, L.	Mallow Velvet leaf	600	8	1.3	
2	Datura stramonium, L.	Jamestown Weed	800	136	17	Plants strong.
3	Ambrosia artemsiaefolia, L.	Rag Weed	80	4	5	T.
4	Solanum carolineus, L.	Horse Nettle	600	320	53	Germination good.
5	Rumex altissimus, wood.	Narrow Dock	400	10	2 5	
6	Agrostemma Githago, L.	Cockles	1200	6	.5	Germination poor.
7	Sisymbrium allissirnum, L.	Wild Mustard	800	12	1.5	
8	Polygonum Hydropiper, L.	Smart Weed	320	24	7.5	Plants strong.
9	Lepidium campestre, L.	Pepper Weed	1000			
10	Ipomoea hederacea, Jocq.	Morning Glory	400			
11	Bidens bipennata, L.	Spanish Needles				
	Total,		6200	520	8.2	
	Totals for tables 9 and 10....		23400	748	3.1	

The experimental plots were watered and cared for to the best advantage and notes were taken from day to day. Numbers 1A and 2A began to show evidence of growth in a very few days, and in a week's time the little plants were seen pushing their way through the washed manure. In plot 1A wheat, crab grass and rye were the first to come up and the rest followed in order as found in table 6. In plot 2A Velvet leaf and Jamestown weed were the first to appear and the rest appeared according to order in the table 7. On the whole, the growth was very irregular and some did not start to grow until the fifth week.

Numbers 1B, 2B and 3A showed no signs of growth whatever until the beginning of the third week, at which time they began to appear in about the same order as before, only they were much slower and much more irregular in doing so. Fewer of them grew, and though in some of the varieties a few plants made their appearance early but soon withered away and no more came until much later, when a considerable number started to grow and did well.

The foregoing tables give tabulated results with remarks when necessary. The results were compiled from the notes that were taken daily during a period of 60 days from the time when the manure was placed in the greenhouse.

In the tables numbered with figures and letters it will be observed that the numbers placed in the column headed, No. seeds fed, are very irregular. This is due to the fact that these numbers are based on the percentage of germination as found and shown in tables 3, 4 and 5. Two thousand seeds were fed in each case, but it is only right that we should consider the number that would have grown had they been planted under ordinary circumstances.

Should it appear in the table that more grew than was fed to the animal in the beginning, we must stop to consider that the number fed in the column so marked is based on the percentage of germination, and must conclude that the digestion exerted a favorable influence on the germination of that particular variety by causing more of them to germinate than would otherwise have germinated had the seeds been planted before passing through the body of an animal.

SUMMARY.

The above results were obtained through experiments concerning the vitality of weed seeds under the influence of their distribution by manure along two different lines; namely, the effect of fermenting manure on the vitality of weed seeds (seeds introduced through bedding), and the effect upon the vitality of weed seeds after passing through the digestive channel of domestic animals (seeds fed to animals).

The first part of the experiment was accomplished so as to cover the condition where manure remains for 6 months in a barnyard pound or pile. The second covered conditions where the manure remained on piles for a short while, as when shipped by carload lots from cities.

From the above results the following conclusions seem justified:

1st. When manure is allowed to ferment in piles for 6 months no danger of distributing weed seeds is incurred.

2nd. When manure is allowed to remain in piles and undergoing partial fermentation, little danger of distribution is incurred.

The second part of the experiment which dealt with the effect upon the vitality of weed seeds after passing through the digestive channels of domestic animals was accomplished so as to bring about three existing conditions.

1st. Manure hauled direct from the stable to the field as a top dressing and left there exposed to the washing of the rains.

2nd. Where the manure is hauled directly from the stable to the field where it is immediately plowed under.

3rd. Where the domestic animals are allowed to run in the pasture and the droppings are allowed to remain wherever they chance to fall.

From the above tables in the latter part the following results were obtained:

1st. Where the manure was hauled directly from the stable as a top dressing an average of only 12.8' per cent of the seeds fed to animals germinated. (See tables 6 and 7.)

2nd.. Where manure was hauled directly from the stable upon the land and plowed under 2.3 per cent of the seeds fed to animals came up. (See table 8.)

3rd. Where the droppings remained on the pasture fields unadulterated as they fell an average of only 3.1 per cent of the seeds fed to animals germinated. (See tables 9 and 10.)

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